# FT. DETRICK
# BOILER PLANT STUDY
# EEAP - DACA01-94-D-0037

# FINAL REPORT

Vol 1 of 2



Prepared by



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**FT. DETRICK**
**BOILER/STEAM SYSTEM STUDY**

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# 1.0 EXECUTIVE SUMMARY

## 1.1 General

The following report outlines the findings of an energy study of the Boiler Plant at Fort Detrick in Frederick, Maryland. Entech Engineering Inc. has prepared this study as part of the Energy Engineering Analysis Program (EEAP). Originally the scope of the study was to cover only the Boiler Plant. However, the steam distribution system was added to the scope because of the significant interrelationship between the boiler plant and the distribution system. Steam usage inside the buildings was not part of this study, although steam usage estimates were made for each building in order to prepare a comprehensive steam use model.

A substantial part of the work in this study was to prepare fuel and steam use models. These models simulated on a monthly basis how energy is used for major heating loads. For example, calculations were made to estimate the steam used in each building for space heating, water heating, sterilizers, decontamination, etc.. Also included in the model is the amount of losses for such things as boiler efficiency, heat loss from pipes, lost condensate, etc.. The developed steam and fuel use models were then balanced such that the model matched the actual steam production and fuel use on a monthly basis.

The total energy usage in the Boiler Plant in 1994 is shown in the following table. Oil and natural gas costs are for the boilers, which supply heat to the total base. The electric usage is for only the equipment inside the Boiler Plant. The total cost for fuel is approximately $3 million per year. Electric cost for the Boiler Plant is an additional $50,000 per year.

**1994 Energy Usage for Fort Detrick Boiler Plant**

| Energy | Energy Unit Total | mmBtu Total | Cost |
|---|---|---|---|
| Natural Gas ($3.53/mcf) | 656,537* | 676,233 | $2,317,600* |
| No. 6 Fuel Oil ($0.42/gal) | 1,645,571 | 246,326 | $691,100 |
| Electric Demand ($8.97/kW) | 2,416 | N/A | $21,700 |
| Electric Usage ($0.024/kWh) | 1,345,600 | 4,592 | $32,300 |

* This is from the log data used for ECO evaluations.

After the fuel use models were developed and balanced with the actual fuel bills, Energy Conservation Opportunities (ECOs) were identified for further analysis. In all, thirty (30) ECOs were identified by both Fort Detrick personnel and Entech. These ECOs and the results of our analyses are listed in Table 1.1.1 and are classified as follows:

B - Boiler Plant
O - Operations
S - Steam System or site
P - Boiler Plant
L - Lighting

## Fort Detrick ECO List
## Table 1.1.1

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Energy Savings (mmBtu) |
|---|---|---|---|---|---|---|---|
| B-1 | Feedwater Treatment | N/A | N/A | N/A | N/A | N/A | N/A |
| B-2 | Stack Economizers | $253,000 | $16,500 | ($10,000) | 34 | 0.85 | 1485 (No.6 Oil)<br>3899 (Nat. Gas) |
| B-3 | Automatic Blowdown Controls | $145,000 | $9,800 | $3,000 | 11 | 1.7 | 2860 (Nat. Gas) |
| B-4 | New Burners | $200,000 | $14,900 | $0 | 13 | 1.5 | 2521 (No.6 Oil)<br>2299 (Nat. Gas) |
| B-5 | Oxygen Trim Controls on Boiler | $75,000 | $18,000 | ($1,000) | 4.4 | 4.8 | 5248 (Nat. Gas) |
| B-6 | Air Preheaters | $1,096,000 | $34,100 | ($10,000) | 45 | 0.60 | -1520 (kWh) -6979 ($kW)<br>6336 (No.6 Oil)<br>9929 (Nat .Gas) |
| B-7 | Supply Combustion Air from Ceiling | $58,000 | $3,900 | ($500) | 17 | 1.5 | -199 (kWh) -870 ($Kw)<br>882 (No.6 Oil)<br>987 (Nat. Gas) |
| B-8 | Update Instruments & Controls | N/A | N/A | N/A | N/A | N/A | N/A |
| B-9 | New Steam Metering | $54,000 | $950 | ($1,000) | $\infty$ | 0.09 | 271 (Nat. Gas) |
| O-1 | Shut off Standby Boilers | $5,000 | $87,700 | $0 | 0.13 | 158 | 10995 (Nat. Gas) |
| O-2 | Improve Boiler Sequencing | $5,000 | $41,000 | $0 | 0.12 | 171 | -2273 (No.6 Oil)<br>13655 (Nat. Gas) |
| O-3 | Summer Shutdown of Boiler Plant | $4,058,000 | ($13,500) | ($25,000) | $\infty$ | 0.63 | -17259 (kWh)<br>-12881 ($kW)<br>-133250 (No.2 Oil)<br>-78 (No.6 Oil)<br>224817 (Nat. Gas) |
| O-4 | Replace Less Efficient Boilers | $1,772,000 | $121,000 | $0 | 14.9 | 1.4 | 15031 (No.6 Oil)<br>22410 (Nat. Gas) |
| O-5 | Fuel Use Selection Plan | $5,000 | $215,000 | ($10,000) | 0.02 | 1019 | -271508 (No.6 Oil)<br>284831 (Nat. Gas) |

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Energy Savings (mmBtu) |
|---|---|---|---|---|---|---|---|
| O-6 | Alternate Fuels | $5,000 | $131,000 | $0 | 0.04 | 549 | 38192 (Nat. Gas)<br>*simulated |
| S-1 | Cogeneration | $10,045,000 | $735,800 | ($457,000) | 13.7 | 0.63 | 199046 (kWh)<br>719304 ($kW)<br>270118 (Nat. Gas) |
| S-2 | New Boiler Plant | $4,304,000 | $162,800 | ($200,000) | $\infty$ | 0.09 | 18325 (No.6 Oil)<br>31888 (Nat. Gas) |
| S-3 | Steam Pressure Reduction | $112,000 | $39,700 | $0 | 2.8 | 7.4 | 11505 (Nat. Gas) |
| S-4 | Improve Condensate Return | $321,000 | $43,500 | $0 | 7.4 | 2.2 | 12696 (Nat. Gas) |
| S-5 | Correct Sizing of Traps (Deleted) | N/A | N/A | N/A | N/A | N/A | N/A |
| S-6 | Steam & Condensate Metering | $247,000 | $14,500 | ($15,000) | $\infty$ | 0.33 | 4217 (Nat. Gas) |
| S-7 | Insulate Steam & Condensate Line | $1,008,000 | $184,700 | $0 | 5.5 | 2.9 | 53264 (Nat. Gas) |
| S-8 | Replace Steam Humidification Ultrasonic | $87,000 | ($1,000) | ($2,000) | $\infty$ | -0.17 | 2132 (Nat. Gas)<br>-92 (kWh)<br>-834 ($kW) |
| S-9 | Sewage Storage Tank Insulation | $298,000 | $7,300 | ($1,000) | 47 | 0.46 | 108 (Nat. Gas) |
| S-10 | Reduce Contaminate Sewage | $373,000 | $37,700 | $0 | 9.9 | 2.1 | 11021 (Nat. Gas) |
| P-1 | Turbine Drives on Feedwater Pumps | $60,000 | $4,000 | ($1,000) | 30 | 0.10 | 715 (kWh)<br>3034 ($kW)<br>-1339 (Nat. Gas) |
| P-2 | Efficient Motors | $22,500 | $800 | $0 | 29 | 0.54 | 75 (kWh) 332 ($kW) |
| P-3 | Variable Speed Drives | $133,000 | $6,660 | ($2,000) | 28 | 0.55 | 600 (kWh)<br>2458 ($kW) |
| L-1 | Boiler Plant Lighting | $17,500 | $600 | $1,000 | 11 | 1.1 | 50 (kWh)<br>215 ($kW) |
| L-2 | Exit Sign to Fluorescent | $100 | $11 | $25 | 2.7 | 4.4 | 1 (kWh)<br>4 ($kW) |

## 1.2 Conclusion

In general, the Boiler Plant appears to be in good condition and maintained very well. The Boiler Plant operations are understood by the Boiler Plant personnel, who appear dedicated to operating the equipment in a quality manner.

Boiler Plant operations impact only a portion of the energy usage. From our investigation there appeared to be less oversight on the steam distribution system, and how the steam is used inside the buildings. Energy conservation opportunities have been identified for the distribution system. Steam use inside the buildings was not part of the work scope for this study.

In summary, a total of ten (10) Energy Conservation Opportunities (ECO) have been recommended for implementation out of the thirty (30) identified in this report. The ECOs were then categorized into one of five types of project. The five include:

1) Recommended ECIP
2) Recommended Non-ECIP O&M projects
3) Recommended Non-ECIP LC/NC projects
4) Recommended Non-ECIP General projects
5) Non-feasible (listed as group in Section 7 only)

The criteria used to place the ECOs into these categories is detailed in Section 7. Of those, only one is considered to be eligible for ECIP designation. That project, ECO S-10, assumes that contaminated sewage can be reduced by approximately 20%. Entech feels that process changes can probably be made to separate "clean sewage" from "contaminated sewage". This could be done by

adding sewage piping, lift stations, etc. An additional study is underway by Fort Detrick to identify the scope for further action. The results of this study, when completed, should be examined to determine if a 20% reduction of contaminated sewage can be achieved for a cost of $373,000 or less. If so, the project will qualify as an ECIP project.

### Recommended ECIP Projects

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Energy Savings (mmBtu) |
|---|---|---|---|---|---|---|---|
| S-10 | Reduce Contaminated Sewage | $373,000 | $37,700 | $0 | 9.9 | 2.1 | 11021 (Nat. Gas) |

The remaining nine (9) ECOs that are recommended include two (2) O&M projects, five (5) Low Cost/No Cost (LC/NC) projects, and two (2) General projects. All three lists are shown in the following tables.

### Recommended Non-ECIP O&M Projects

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Energy Savings (mmBtu) |
|---|---|---|---|---|---|---|---|
| S-4 | Improve Condensate Return | $321,000 | $43,500 | $0 | 7.4 | 2.2 | 12696 (Nat. Gas) |
| S-7 | Insulate Steam & Condensate Line | $1,008,000 | $184,700 | $0 | 5.5 | 3.8 | 53264 (Nat. Gas) |

## Recommended Non-ECIP LC/NC Projects

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Energy Savings (mmBtu) |
|---|---|---|---|---|---|---|---|
| O-1 | Shut off Standby Boilers | $5,000 | $87,700 | $0 | 0.13 | 158 | 10995 (Nat. Gas) |
| O-2 | Improve Boiler Sequencing | $5,000 | $41,000 | $0 | 0.12 | 171 | -2273 (No.6 Oil)<br>13655 (Nat. Gas) |
| O-5 | Fuel Use Selection Plan | $5,000 | $215,000 | ($10,000) | 0.02 | 1019 | -271508 (No.6 Oil)<br>284831 (Nat. Gas) |
| O-6 | Alternate Fuels | $5,000 | $131,000 | $0 | 0.40 | 549 | 38192 (Nat. Gas)<br>*simulated |
| S-3 | Steam Pressure Reduction | $112,000 | $39,700 | $0 | 2.8 | 7.4 | 11505 (Nat. Gas) |

514,400
− 10,000
$504,400

85,397

## Recommended Non-ECIP General Projects

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Energy Savings (mmBtu) |
|---|---|---|---|---|---|---|---|
| B-5 | Oxygen Trim Controls on Boiler | $75,000 | $18,000 | ($1,000) | 4.4 | 4.4 | 5248 (Nat. Gas) |
| L-2 | Exit Sign to Fluorescent | $100 | $11 | $25 | 2.8 | 5.3 | 1 (kWh)<br>4 ($kW) |

In order to go further we recommended the ECOs be addressed as follows:

A. Non-ECIP O&M Projects:

Budget $1.3 million for repairing leaks in the steam and condensate lines, and insulate steam and condensate lines that are not insulated or poorly insulated (ECO S-4 and S-7). Part of this work will include surveying the piping to prioritize where the improvements should be made first.

B. Non-ECIP LC/NC Projects:

Implement Non-ECIP LC/NC Projects where possible. These are low cost items that have the potential for significant savings. In some cases, standard operating procedures should be scrutinized carefully to see if they can be modified without impacting steam customers.

C. Non-ECIP General Projects:

The two projects listed are not of significant size, but should be implemented.

D. Although not part of this study, we recommend the buildings served by the steam system be analyzed for potential ECOs. The models in this study can be used to identify buildings where steam usage is believed to be high.

Many of the ECOs have "interactive" savings, which means you cannot add the savings from all the ECOs to get total cost savings. Some ECOs cannot realize the full savings estimated if another related ECO is implemented. For example, ECO O-6 is affected by the strategies described in ECO O-5. Depending on what decisions are made, it is believed total energy cost savings realized could be over $500,000 per year, even with interactive savings eliminated from the savings calculations..

# 2.0 METHODOLOGY

## 2.1 General

The intention of this study is to assess current energy consumption at the Boiler Plant, and provide recommendations to improve energy efficiency. Entech has developed a very thorough format which is adhered to during the development of an energy report. This format has permitted Entech to construct comprehensive reports in a smooth and timely process. Entech has employed the format in the preparation of over three-hundred (300) energy studies for commercial, industrial, and institutional clients.

The following is a listing of the components in Entech's methodology for completing energy studies:

1. Kickoff Meeting
2. Gather Existing Data
3. Site Inspection
4. Model Existing Energy Characteristics
5. Energy Conservation Opportunities
6. Draft Report Generation
7. Client Review
8. Final Report Generation

## 2.2 Kickoff Meeting

In order to initiate the process, Entech scheduled a kickoff meeting at Fort Detrick in October of 1994. Entech was represented by William McMahon, Jeffrey Euclide, Daniel Gerhart, and Danette Ernst. John Bennett and Ted Hahn represented Fort Detrick. Jim Sweger was present from the U.S. Army Engineer District, Baltimore.

The purpose of the meeting was to introduce all parties and explain the process Entech was planning to follow during the study. In addition, Fort Detrick's expectations were noted and incorporated into the project.

## 2.3 Gather Existing Data

Prior to the first site inspection, Entech requested electric, gas and oil billing data and boiler plant logs from Fort Detrick. Fort Detrick also provided previous studies pertaining to the boiler plant and steam distribution system. Entech reviewed the data to determine the operating profiles of the boiler plant and to determine which buildings use steam from the central system.

## 2.4 Site Inspection

Entech performed site inspections of Fort Detrick during the months of December 1994, and of January and March 1995.

During the December 1994 visit, Entech surveyed the steam distribution system and the buildings served by it. Entech did not enter any of the buildings. A photograph was taken of each building observed to be connected to the steam system and the following information about each building was recorded.

1. Building Number
2. Building Name
3. Building Use
4. Estimated Square Footage
5. Construction Type (Pre-Engineered, Masonry, Wood Frame, etc.)
6. Estimated Age
7. Does the building appear to be insulated?
8. Quantity and Type of Windows
9. Type of Roof

10. Estimated Building Ventilation Rate
11. Does the building appear to use steam for process?
12. Does the building appear to use steam for domestic hot water?
13. Does the building appear to have a kitchen that may use steam?
14. Does the building appear to return condensate to the boiler plant?
15. Other notes

Entech gathered additional information about the larger steam consuming buildings during the January 1995 visit to the site. Entech spoke to people from Fort Detrick's pipe shop about steam use in Army occupied buildings and to engineers from the National Cancer Institute (NCI) about steam use in the buildings that are used by NCI.

Entech also surveyed the Boiler Plant, Building 190, during the January 1995 visit to the site. During this survey, information was obtained pertaining to the electric lighting and electric usage (motors, heaters, etc) in the building. Also, the layout of the plant and its systems was reviewed to determine a basic understanding of the operation.

During the March 1995 visit, Entech made additional evaluations of the Boiler Plant systems and operations.

## 2.5 Model Existing Energy Consumption

### 2.5.1 General

After the site investigation phase is complete, Entech models the existing operation of energy users at the facility. Entech uses in-house computer programs, purchased computer programs, and literature to assist in calculating current energy costs for producing steam, and operating the boiler plant. The four main computer models used to estimate energy use are as follows:

1. Steam Use Model
2. Fuel Use Model
3. Lighting Model
4. Electric Model

The standard abbreviations used in this report include the following:

**Standard Abbreviations**

| Key | Description | Key | Description |
|---|---|---|---|
| Ave | Average | lbm | Pound Mass |
| Btu | British Thermal Unit | lbs | Pounds |
| Btuh | British Thermal Unit per Hour | lb/hr | Pounds per Hours |
| cfm | cubic feet per minute | mlbs | Thousand Pounds |
| °F | Degrees Fahrenheit | mcf | Thousand Cubic Feet |
| ft | Feet | min | Minute |
| gal | Gallon | mmBtu | Million British Thermal Unit |
| hr | Hour | mo | Month |
| in | Inches | psig | Pounds per Square Inch Gauge |
| kW | Kilowatt | sf | Square Foot |
| kWh | Kilowatt per Hour | yr | Year |

### 2.5.2 Steam Use Model

Entech developed a model that examines how all of the steam produced at the boiler plant is used. Most of the steam produced is used at the buildings for heating, reheat, humidification, domestic hot water, and process. The boiler plant uses some of the steam produced to preheat boiler feedwater, heat the No. 6 fuel oil, soot blowing, and oil atomization. The remainder of the steam produced is lost in the distribution system through leaks and heat loss from the piping. Each of the steam uses will be examined in the energy model section of this report. Please refer to the energy model section for more detail about the following steam uses.

1. Space Heating
2. Reheat
3. Humidification
4. Domestic Hot Water
5. Autoclaves and Cage Washers
6. Sewage Decontamination
7. Other Process
8. Boiler Plant Steam Use
9. Distribution Losses

### 2.5.3 Fuel Use Model

For evaluating fuel use, Entech models the natural gas and fuel oil data summarized in the billing section relative to the steam production from the plant. Costs are determined for each fuel, and tabulated by month for 1994. Lastly the fuel costs are matched with the steam use model for determining the impact of each category.

### 2.5.4 Lighting Models

Entech uses a Lotus spreadsheet program to model the lighting load in the boiler plant. A sample lighting model is shown in Table 2.5.4.1.

Information collected during the site inspections was entered into the program to develop a monthly estimate of energy cost, usage, and demand which is associated with building lighting. The program breaks down the costs by room or area. A definition of each column heading in the model is as follows:

**Area** Location of lighting fixtures.

**Type** Distinguishes fixtures with ballasts from fixtures without ballasts. The number 1.15 is the ballast factor included for fixtures which incorporate ballasts. These include Fluorescent, High Pressure Sodium, Metal Halide, and Mercury Vapor. A 15% increase in electrical load created by the ballast is accounted for in using the factor. A ballast factor of one (1) is used for incandescent fixtures since there are no ballast losses.

**Illum (FC)** Footcandle light level reading measured in each area (not included in this report).

**# of Fixtures** Number of fixtures in area. Fixtures used only for emergency lighting are not included.

**Lamps/Fixture** Number of lamps per fixture.

**Watts per Lamp** The rated electric loss per lamp or bulb. (Ballast losses not included.)

**Total Watts** Total watts is calculated by multiplying "(Type)" x (# of fixtures) x (Lamps per fixture) x (Watts per lamp).

**hrs/wk** The estimated hours of operation in one week.

**% of kW on Peak** The estimated amount of connected load that is contributing to the typical monthly on-peak electrical demand. Normally the percent (%) on peak is less than 100% to account for burned out lamps.

**kW on Peak** Calculated by multiplying (Total watts) x (% on-peak) / (1,000 watts/kW).

**Monthly kWh** Calculated by multiplying (Total watts) x (hrs/wk) x (4.3 wks/mo) / (1,000 watts/kW).

**Monthly Costs** Calculated by multiplying kW and kWh by the incremental rates for demand and usage shown at the bottom of the lighting model.

LIGHTING MODEL
FORT DETRICK BOILER PLANT
TABLE sample

| ROOM OR AREA DESCRIPTION | FIXTURE TYPE (1) | LIGHT LEVELS (FC) | NO. OF FIX. | LAMPS PER FIXTURE | WATTS PER LAMP | TOTAL WATTS | HOURS PER WEEK | PERCENT OF KW ON-PEAK | DEMAND KW ON-PEAK | USAGE KWH PER MONTH | ELECTRIC COSTS MONTHLY DEMAND (KW) | ELECTRIC COSTS MONTHLY USAGE (KWH) | ELECTRIC COSTS MONTHLY COST $ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
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INCREMENTAL DEMAND COST $/KW =
INCREMENTAL USAGE COST $/KWH =

NOTE #1: FOR BALLASTED FIXTURES A BALLAST FACTOR OF 1.15 IS USED, INCANDESCENT FIXTURES USE 1.

**G:\PROJECTS\4130.03\SS\LMODEL.WK1** **26-Jul-95**

### 2.5.5 Electrical Model

Entech's Electrical Model is a computer spreadsheet used to identify electric loads within the building and to identify the individual contribution to electrical demand, usage, and cost.

Loads have been identified from the site investigation. Information from the lighting model is reflected in the electric model.

It is important to realize that the electric model is an approximation of the electricity used by each load. It shows general relationships and gives reasonable allocation of electrical demand, usage, and cost.

Demand (kW) contributions and estimated kWh usages are then included in subsequent calculations of the Energy Conservation Opportunities of Section 6.0 for the boiler plant.

A sample Electric Model is shown in Table 2.5.5.1. A description of each column heading follows:

**Connected Load** The total connected electric load, expressed in kW, is shown for both the heating season and the cooling season.

**Winter Demand** The average kW contributing to the billing demand each month. Winter months include December, January, February, and March.

**Intermediate Demand** The average contribution to billing demand in the intermediate months of April, May, October, and November

**Summer Demand** The average contribution to billing demand in the summer months of June, July, August, and September.

**Winter Usage** The estimated full load equivalent operating hours that the load operates in a day. The kWh/mo. in the next column is then calculated by multiplying (connect load) x (hrs/day) x 30. The lighting load is calculated in the lighting model and included within the electrical model.

**Intermediate Usage** The same as winter usage.

**Summer Usage** The same as winter usage.

**Totals per Year** The kW/month for each season is multiplied by 4 mo/season to calculate kW/season for winter, intermediate, and summer. They are then added together to get annual kW. kWh/year is calculated the same as kW. The annual cost is calculated by multiplying kW and kWh by the incremental costs.

**Electric Model**
**Fort Detrick Boiler Plant**
**Table sample**

| No. | Description | Total Connected Load (KW) | Winter Demand KW/Month | Inter Demand KW/Month | Summer Demand KW/Month | Hours Per Day | Winter Usage KWH/Month | Hours Per Day | Inter Usage KWH/Month | Hours Per Day | Summer Usage KWH/Month | Annual Demand KW/Yr. | Annual Usage KWH/Yr. | Annual Cost $/Yr. | No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | 1 |
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| 54 | | | | | | | | | | | | | | | 54 |
| 55 | | | | | | | | | | | | | | | 55 |
| 56 | | | | | | | | | | | | | | | 56 |
| 57 | | | | | | | | | | | | | | | 57 |
| 58 | | | | | | | | | | | | | | | 58 |
| | TOTALS | | | | | | | | | | | | | | |

INCREMENTAL DEMAND COST $/KW =
INCREMENTAL USAGE COST $/KWH =

WINTER: DEC, JAN, FEB, MAR
INTER: APR, MAY, OCT, NOV
SUMMER: JUN, JUL, AUG, SEP

G:\PROJECTS\4130.03\SS\EMODEL.WK1

### 2.5.6 Heating Degree Days

Monthly weather in degree days is shown in Table 2.5.6.1. The data is used in the space heating model to calculate heating costs for the base. The site does not utilize steam for heating during the sumer months, June through September.

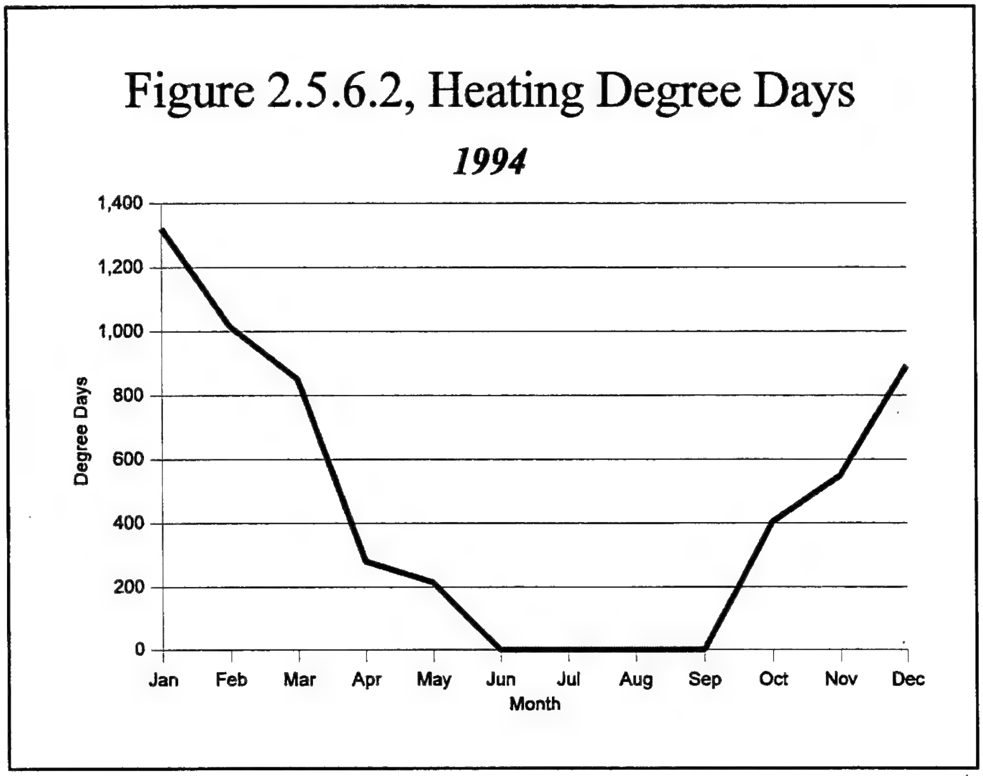
The degree day procedure for estimating heating energy requirements is based on the assumption that, on a long-term average, solar and internal gains will offset heat loss when the mean daily outdoor temperature is 65 degrees F. During a 24 hour period, every degree lower than 65 degrees F is considered a degree day. For example, on a day when the mean temperature is 20 degrees F, the number of degree days recorded would be 45 degree days (65 - 20 = 45).

Fort Detrick collected heating degree day information at the boiler plant. This information correlates well with the steam requirements observed at the boiler plant. The measured total for the heating season is 5,532 heating degree days.

Figure 2.5.6.2 shows heating degree days in graph form.

**Heating Degree Days**
**Table 2.5.6.1**

| Month | 1994 |
|---|---|
| January | 1,322 |
| February | 1,017 |
| March | 851 |
| April | 281 |
| May | 215 |
| June | 0 |
| July | 0 |
| August | 0 |
| September | 0 |
| October | 405 |
| November | 549 |
| December | 892 |
| **Total** | **5,532** |




### 2.5.7 mmBtu/Unit

The following energy values have been used in the energy calculations in this report.

**Table 2.5.7.1 mmBtu/Unit**

| Type | Btu/Unit |
|---|---|
| Natural Gas (mcf) | 1,030,000 |
| Electricity (kWh) | 3,413 |
| No. 6 Oil (gal) | 149,690 |
| 110 PSIG Steam (lb) | 1,003 |

Note: The steam value shown above is the energy required to heat steam from 220°F feedwater to steam at a line pressure of 100 psig.

## 2.6 Energy Conservation Opportunities (ECOs)

After the energy models have been finalized, Entech begins to analyze the ECOs which were developed during the site inspection. An ECO describes an idea for decreasing energy costs, and the write up consists of the following sections:

1. Existing Condition Description
2. Proposed Condition Description
3. Construction Cost Estimates
4. Energy Savings
5. Maintenance Savings
6. Discussion

### 2.6.1 Existing Condition

A general description of the existing condition will be provided as well as current annual energy costs.

### 2.6.2 Proposed Condition Description

The project which is to be implemented will be described in adequate detail. The expected energy cost for the proposed project will be formulated and shown.

### 2.6.3 Construction Cost Estimates

The construction cost estimates prepared for this study are considered to be "conceptual" in nature. They are conceptual because they are based upon engineering design that is less than one percent of a complete detailed design effort for such a project.

The cost estimates are broken down into material, labor, and engineer components. Calculations or a spreadsheet is usually provided with each ECO.

The final results of a project can vary significantly from the "Conceptual" cost estimate. The American Association of Cost Engineers (AACE) generally states that an accuracy range of plus or minus 20% from the total estimated cost is possible. Variations beyond this range are possible for the stated scope, but not likely.

Since it is not possible to know the variations that can occur in the future, nor control certain technologies, contractors, or general economic conditions, the costs estimated herein should not be construed as fixed or precise. Rather they are estimates which will require a great deal of effort to manage until the final costs are realized.

### 2.6.4 Cost Savings

This portion of the ECO compares the existing and proposed energy costs and notes increases or decreases in energy consumption.

### 2.6.5 Discussion

Entech notes the expected payback period and return on investment for the ECO. Any additional benefits or concerns are noted in this section.

### 2.6.6 Life Cycle Cost Analysis Summary

The life cycle costs were forecasted with the Blast: LCCID version 1.0, Level 80 Program. LCCID is an economic analysis computer program tailored to the needs of the Department of Defense (DoD). It is intended to be used as a tool in evaluation and ranking design alternatives for new and existing buildings. LCCID has built-in calculation procedures recognized as a standard for the DoD. The following is the specific criteria and other guidance embodied in LCCID according to the LCCID users manual.

The specific criteria and other guidance embodied in LCCID are:

1. Office of Management and Budget (OMBP Circular A-94, March 27, 1972. OMB Circular A-94 has a new version (October 29, 1992) but a final decision on incorporating the new circular into tri-service criteria has not been determined.

2. Code of Federal Regulations, 10 CFR 436A, January 25, 1990. Annual fuel escalation rates are published by NIST (National Institute of Standards and Technology) under sanction by DoE.

3. Memorandum of Agreement on Criteria/Standards for Economic Analysis/Life Cycle Costing for MILCON Design, 18 March 1991. This memorandum obviated the need for separate criteria in the three services (Army, Air Force, and Navy) of the Department of Defense.

4. DoD Energy Conservation Investment Program (ECIP) Guidance. This guidance uses the memorandum from Item 3, as its basis, but also has some qualifying factors for energy conservation projects and specifies its own format.

The LCCID Program is structured as shown on Table 2.6.6.1, ECIP Study LCCID Ready Reference, which can be found at the end of this section. This table was obtained from the LCCID program users manual.

The following criteria was selected/entered into the LCCID program to obtain the Life Cycle Cost Analysis Summaries prepared as part of each ECO:

A. Common criteria selected for all life cycle cost analysis summaries:

— Military Construction Army
— User Entry of Consumption Values
— ECIP Project
— Energy Escalation Rates for FY94 (only option available)
— English Units

B. Common criteria entered into all life cycle cost analysis summaries:

— ECIP Economic Life: Twenty years

— Location: Pennsylvania

— Electric Usage Cost: $7.03 per mmBtu

$$\left( \frac{.024}{kWh} \, x \, \frac{kWh}{3{,}413 \ Btu} \, x \, \frac{1 \ x \ 10^6 \ Btu}{mmBtu} \right)$$

— Project Number: #4130.03

— Fiscal Year: 1995

— Project Title: EEAP

— Installation Name: Ft. Detrick Army Depot

— Study Preparer: JED

— Salvage Value: $0

C. Criteria entered into life cycle cost analysis summaries from the ECO:

— Discrete Portion Title: ECO #

— Construction Cost: Dollars

— Design Cost: Dollars (Program default of 6% of construction cost rounded off.)

— Supervision, Inspection, and Overhead (SIOH): Dollars (Program default of 5.5% of construction cost rounded off.)

— Energy Savings: mmBtu (Electrical, oil, gas, etc.)

— Demand Savings: Annual Dollars (Electrical only)

— Annual Recurring Savings: Maintenance Savings

A sample Life Cycle Cost Analysis Summary Report is shown in Table 2.6.6.2 located at the end of this section. In this example, all the common criteria noted in 2, Items A and B, was selected or entered into this summary report.

In Part 1 of the summary report, a construction cost of $100,000 and a design cost of $6,000 was assumed (rounded in some cases). The SIOH was rounded off to $6,000 by the user.

In Part 2 of the summary report, an electric energy saving of 1,000 mmBtu/yr was assumed. A $2,000/yr demand savings shown in "2 M" was also assumed.

In Part 3 of the summary report, a maintenance savings of $100/yr was also assumed. In the actual summary report, the above-assumed numbers would originate from an ECO. In the example, the program calculated a simple payback of 12.26 years and a savings to investment ratio of 1.26.

TABLE 2.6.6.1

# ECIP STUDY - LCCID READY REFERENCE

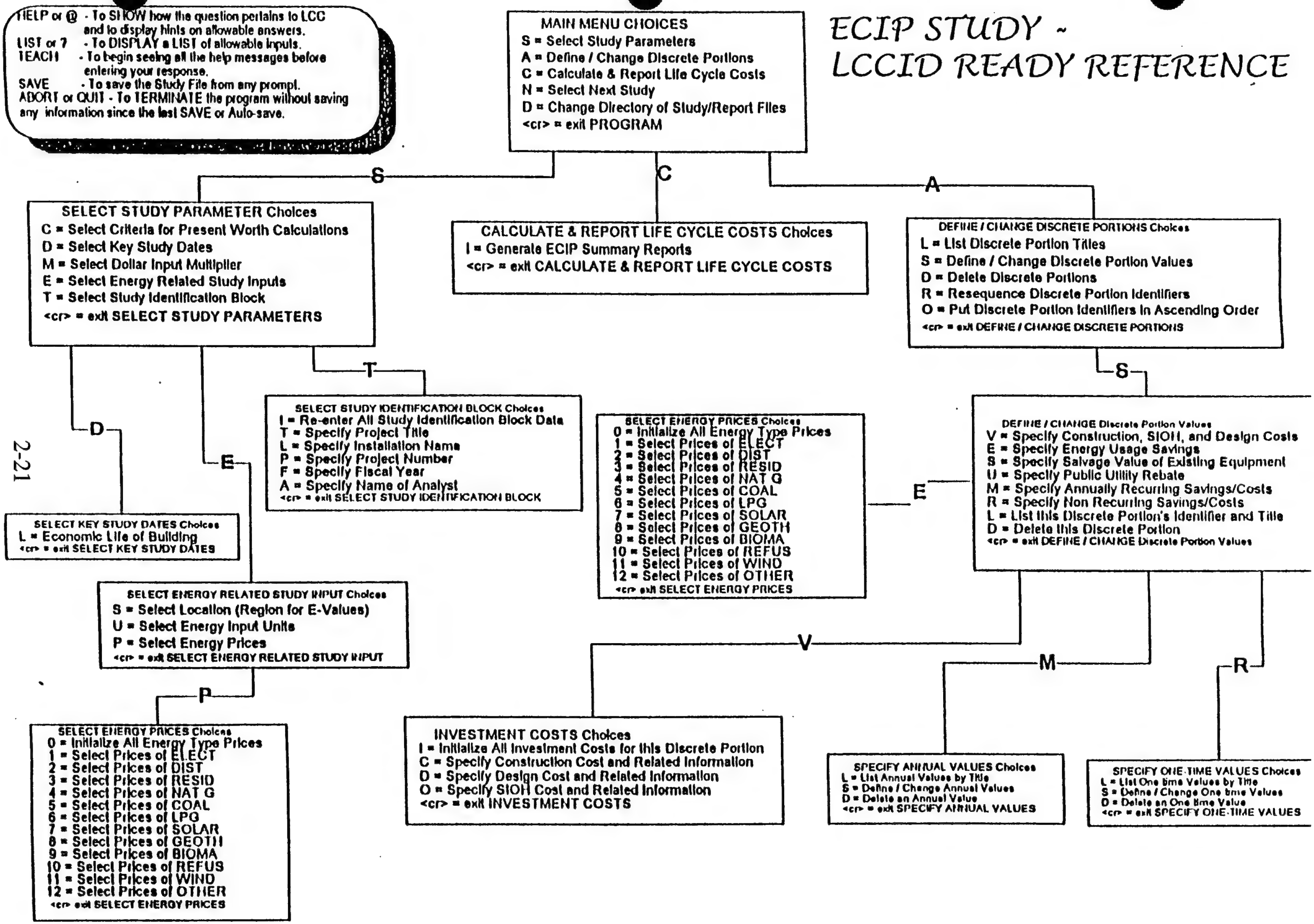


TABLE 2.6.6.2

LIFE CYCLE COST ANALYSIS SUMMARY    STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)    LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK    REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03    FT. DETRICK STEAM STUDY
FISCAL YEAR 1995    DISCRETE PORTION NAME: EXAMPLE
ANALYSIS DATE: 07-20-95    ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 100000. | | |
| B. SIOH | $ 6000. | | |
| C. DESIGN COST | $ 6000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 112000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 112000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 1000. | $ 7030. | 15.61 | $ 109738. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 0. | $ 0. | 20.96 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 2000. | 14.74 | $ 29480. |
| N. TOTAL | | 1000. | $ 9030. | | $ 139218. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)    $ 100.
  (1) DISCOUNT FACTOR (TABLE A)    14.74
  (2) DISCOUNTED SAVING/COST (3A X 3A1)    $ 1474.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 1474.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 9130.

5. SIMPLE PAYBACK PERIOD (1G/4)    12.27 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)    $ 140692.

7. SAVINGS TO INVESTMENT RATIO    (SIR)=(6 / 1G)=    1.26
   (IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):    4.28 %

## 2.7 Draft Report/Client Review/Final Report

After the previous sections have been substantially completed, Entech proceeds to compile the information into the report format. Entech schedules a meeting with the client to present its findings. A copy of the report is supplied to the client for a more detailed review. The client's review process typically lasts 2-3 weeks.

Entech will then proceed to incorporate the clients review comments and produce a final report. Typically, the final report will be completed within two weeks.

## 3.0 FACILITY DESCRIPTION

### 3.1 General

The Fort Detrick facility is located in Frederick, Maryland. The two (2) square mile site contains over 200 buildings and homes that are occupied by the U. S. Army and the National Cancer Institute. An overview of the portion of the base served by the steam system can be seen by reviewing the Steam Distribution System map in Attachment 8.8.

Fort Detrick's mission is to provide base operations support for the missions of tenant activities on the installation. Such activities include the potentially hazardous research operations of the National Cancer Institute's Frederick Cancer Research and Development Center, the U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID), the U.S. Department of Agriculture's Agricultural Research Service, and the U.S. Army Medical Research and Development Command (USAMRDC).

The Fort Detrick Boiler Plant serves approximately 120 buildings on the site. The availability of steam is vital for research with infectious materials and agents in order to prevent endangering the public as well as the environment. Steam provides sterilization of all liquid waste from contaminated laboratory buildings as well as operation of large and small autoclaves. Steam also provides the heat for laboratory controlled environments (temperature/humidity) as well as the normal requirements of space heating. The existence of a central steam system, as well as a contaminated sewage collection/sterilization system, is the reason why the tenants have located at Fort Detrick.

## 3.2 Boiler Plant

The first portion of Fort Detrick's Boiler Plant, Building 190, was constructed in 1952. The original installation included four (4) 33,000 lb/hr, No. 6 oil-fired boilers, which were numbered 1 through 4. Building 190 was expanded in 1956 to add two (2) 66,000 lb/hr boilers, numbers 5 and 6. In 1966, Boilers No. 3 and No. 4 were replaced by a new 130,000 lb/hr boiler. The new boiler was labeled Boiler No. 3 and eliminated the reference to Boiler No. 4. In 1991, Boilers No. 1 and No. 2 were replaced by two (2) new 65,000 lb/hr boilers. At the present time, the peak "available" capacity of the boilers for the site is at 262,000 lb/hr assuming that the largest boiler, No. 3, could be out of service at anytime. The support systems for the boilers for the most part are of common systems. This includes make-up water with chemical treatment, blowdown heat recovery and softened water; deaerator heating including condensate return; blowdown accumulation and recovery; fuel oil storage, heating and transfer; compressed air; and emergency power (80% of plant operation) via a diesel generator. A summary of the boilers is shown in Table 3.2.1 on the following page.

**Fort Detrick, Building 190**
**Boiler Plant Systems**
**Table 3.2.1**

| No | Capacity (lb/hr) | Yr. Built | Description | Nat. Gas | No. 6 Oil | Stack Econ. | ID Fan | FD Fan |
|---|---|---|---|---|---|---|---|---|
| 1 | 65,000 | 1991 | Packaged Watertube | yes | yes | yes | no | yes |
| 2 | 65,000 | 1991 | Packaged Watertube | yes | yes | yes | no | yes |
| 3 | 130,000 | 1966 | Industrial Watertube | yes | yes | yes | yes | yes |
| 5 | 66,000 | 1953 | Industrial Watertube | yes | yes | no | yes | yes |
| 6 | 66,000 | 1956 | Industrial Watertube | yes | yes | no | yes | yes |

Original Boilers No. 3 and No. 4 were replaced by Boiler No. 3 listed above. Other Boiler numbers remained the same. The total installed capacity of the Boiler Plant is 392,000 lb/hr. A brief description of the boilers, and a summary of the Boiler System Specifics, Common Systems and Support Equipment follow.

### 3.2.1 Description of Existing Boilers

Boiler No. 1 — Cleaver Brooks 65,000 lbs steam per hour, 2 drum, D-style packaged unit, natural gas / No. 6 oil fired burner firing through boiler end. Economizer installed on boiler flue gas outlet. Forced draft fan only. Boiler heating surface is 4,346 sf, and water wall heating surface is 751 sf. Constructed in 1991.

Boiler No. 2 — Cleaver Brooks 65,000 lbs steam per hour. Same as Boiler No. 1.

| | |
|---|---|
| Boiler No. 3 | Erie City 130,000 lbs steam per hour, 2 drum, cross drum, brick set, field erected, total of four natural gas / No. 6 oil burners firing through boiler sidewall. Economizer installed on boiler flue gas outlet. Forced draft and induced draft fans. Boiler heating surface is 10,640 sf, and water wall hearing surface is 2,750 sf. Constructed in 1966. New economizer installed in 1980. |
| Boiler No. 5 | Erie City 66,000 lbs steam per hour, Type IWT, 2 drum, cross drum, brick set, field erected, total of three natural gas / No. 6 oil fired burners. Forced draft and induced draft fans. Boiler heating surface is 7,310 sf, water wall heating surface is 830 sf. Constructed in 1953. |
| Boiler No. 6 | Keeler Co. 66,000 lbs steam per hour, 2 drum, cross drum brick set, field erected, total of three natural gas / No. 6 oil fired burners. Forced draft and induced draft fans. Boiler heating surface 6,168 sf. Water wall heating surface 1,832 sf. Constructed 1956. |

### 3.2.2 Boiler System Specifics

| | | |
|---|---|---|
| Boiler Operating Conditions | 110 psig | (344°F) |
| Boiler Drum Conditions | 115-125psig | (347-353°F) |
| Boiler Header Conditions | 110-112psig | (344-346°F) |
| Distribution Conditions | 90-110psig | (330-344°F) |
| Condensate Return | 5-12psig | (160-220°) |

### 3.2.3 Common Systems

| | | | |
|---|---|---|---|
| Feedwater Temperature | (Ave.) | 220°F | from deaerator |
| Make-up Temperature | (Ave.) | 60°F | to deaerator |
| Condensate Return Temp. | (Ave.) | 165°F | to deaerator |

### 3.2.4 Support Equipment

Deaerators (Qty of 3)
Feedwater pumps (Qty of 5)
Make-up Water (Tank/Pumps etc.)
Condensate Equipment (Tank/Pumps etc.)
Softened Water Equipment (Tank/Pump etc.)
Chemical Feed (Bins/Pumps etc.)
Compressed Air Equipment-Plant only (Air Compressors, Dryers, etc)
Fuel Oil System (Tanks, Pumps, Heaters, etc)

Refer to the electric model in Section 5.14 for details of the boiler plant's equipment. Information in that section pertains to the connected loads and power consumption (i.e., demand and usage). Figure 3.2.2 is a layout schematic of the boiler plant showing the location of major equipment including all electrical users listed in the electric model.

The plant's primary auxiliary systems and equipment are briefly discussed in the following pages..

### 3.2.5 Treatment of Boiler Feedwater

The raw water supply is initially feed through the plant's Zeolite Water Softening Equipment prior to its storage in the Make-up Water Storage Tank. From here the make-up water is sent to one of three deaerators located on the upper level for heating and dearation. In addition, make-up and/or boiler feedwater are treated with various chemicals in an attempt to

remove the remaining corrosive gases, and to stabilize the alkalinity of the water. Salt, phosphates, sodium hydroxide, sulfites and polymers constitute the majority of chemicals involved with the treatment of boiler feedwater at Fort Detrick.

### 3.2.6 Deaerators

Boiler condensate return and make-up water are combined in the three deaerators with pressure reduced steam to remove the majority of dissolved gases. This is done to minimize corrosion in the feedwater piping and boiler tubes. The added steam which includes flashed boiler blowdown also adds heat to the water mix, thus reducing the fuel input requirements.

### 3.2.7 Stack Economizers

Boiler feedwater is pumped from the dearator storage tanks to the individual boiler drums. On three of the Boilers, No. 1, No. 2, and No. 3, the feedwater is first passed through a steam to water heat exchanger, and then through a stack economizer in the high temperature flue gas steam. The reason for doing this is to take advantage, within reason, of excess heat in the flue gas. The purpose for pre-heating the feedwater prior to entering the economizers is to maintain tube surface temperatures above the dew point of the flue gas, minimizing corrosion on the tubes. Once the feedwater exits the economizers it then is piped directly to the boiler drums.

### 3.2.8 Blowdown and Heat Recovery

All five boilers utilize pinch valves for controlling continuous blowdown at a single location near the common blowdown tank. At present, each boiler is manually controlled based on daily evaluations of the individual boiler drum solids concentrations. Flashed steam from the blowdown helps to feed the deaerators, and the blowdown itself is sent through a plate and frame heat exchanger to heat incoming make-up water, from the storage tank, prior to its entry into the deaerators.

### 3.2.9 Natural Gas Supply

Natural gas is supplied by Frederick Gas Company of Frederick, Maryland. During the 1980's a gas main was installed that runs across the Fort Detrick site. The routing placed the line next to the boiler plant allowing for a tap for the plant. The 4" branch to the plant initially comes in at 200 psig, and it is eventually reduced down to 30-35 psig for Boilers No. 1, No. 2, No. 5, and No. 6, and 13 psig for Boiler No. 3. Metering is done at the main by Frederick Gas, and by Fort Detrick personnel with each boiler.

### 3.2.10 Oil Storage and Transfer

Fort Detrick stores No. 6 fuel oil on site for use in the Boiler Plant. The fuel oil is used to supplement gas service from Frederick Gas.

One (1) 400,000 gallon aboveground tank is currently available for fuel oil storage. Ten (10) 53,000 gallon No. 6 oil underground storage tanks were recently removed from the site. A 250,000 gallon aboveground tank will

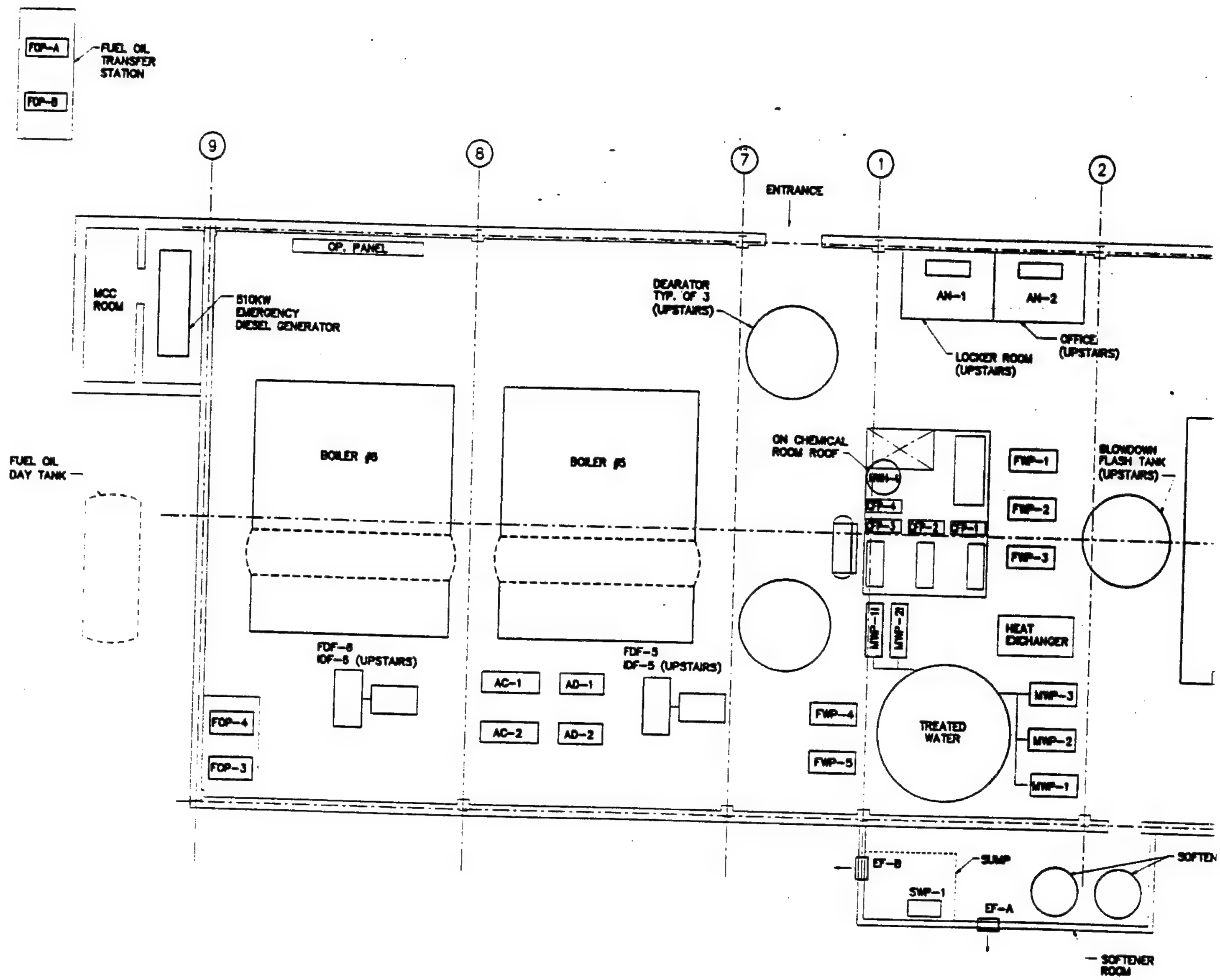
be constructed later this year to replace the removed tanks. Fort Detrick will then have 650,000 gallons of fuel oil storage capacity.

The oil will be pumped from either tank by one of two existing pumps in the pump house on site. The oil will be heated prior to pumping by a suction heater at the tank. The oil is pumped to one of two day tanks when the plant operator decides their levels are too low. Each of these existing day tanks will be replaced with a 12,000 gallon double wall underground storage tank as part of the ongoing fuel storage project.

When oil is required for one of the boilers, the oil is pumped from either of the day tanks with its associated pump and heater set.

The entire fuel oil system is manually operated. The only automatic controls are safety shutoffs to prevent overfilling the day tanks. Metering of the oil is performed by Fort Detrick personnel with each boiler.

1



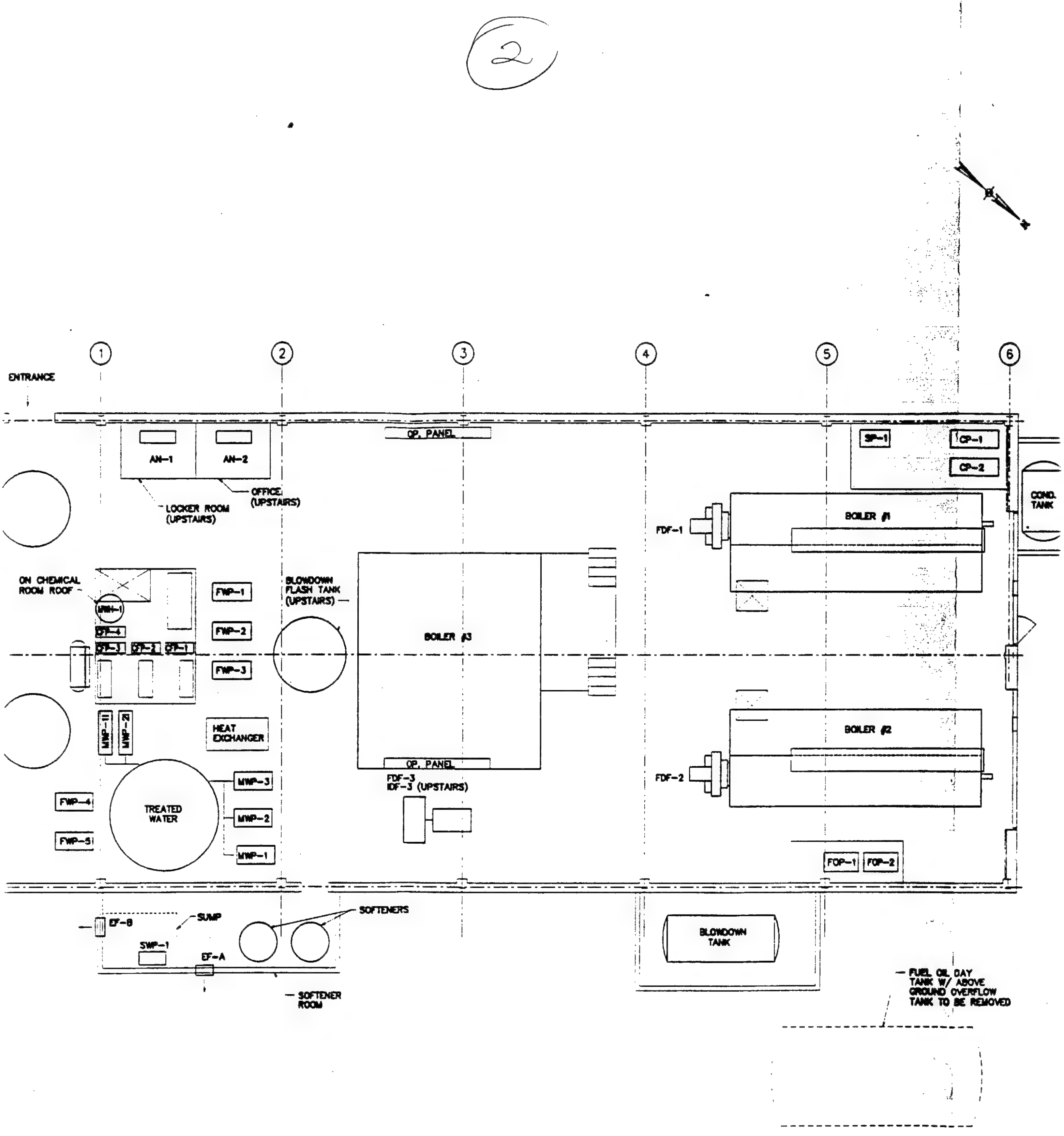

## ABBREVIATIONS

| | |
|---|---|
| AC | AIR COMPRESSOR |
| AD | AIR DRYER |
| AH | AIR CONDITIONER |
| CFP | CHEMICAL FEED PUMP |
| CP | CONDENSATE PUMP |
| EF | EXHAUST FAN |
| FDF | FORCED DRAFT FAN |
| FOP | FUEL OIL PUMP |
| FWP | FEED WATER PUMP |
| HWH | HOT WATER HEATER |
| IDF | INDUCED DRAFT FAN |
| MCC | MOTOR CONTROL CENTER |
| MWP | MAKEUP WATER PUMP |
| SP | SUMP PUMP |
| SWP | SOFTENED WATER PUMP |

## NOTES:

1) LOCATION OF DEARATORS FOR CLARITY. LOCATIONS MAY VARY SLIGHTLY. THE THIRD TANK NOT SHOWN IS LOCATED ABOVE THE TREATED WATER TANK.

2) LOCATION OF FUEL OIL TANKS SOUTHEAST OF BOILER PLANT.

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FORT DETRICK

BOILER

ENTEX

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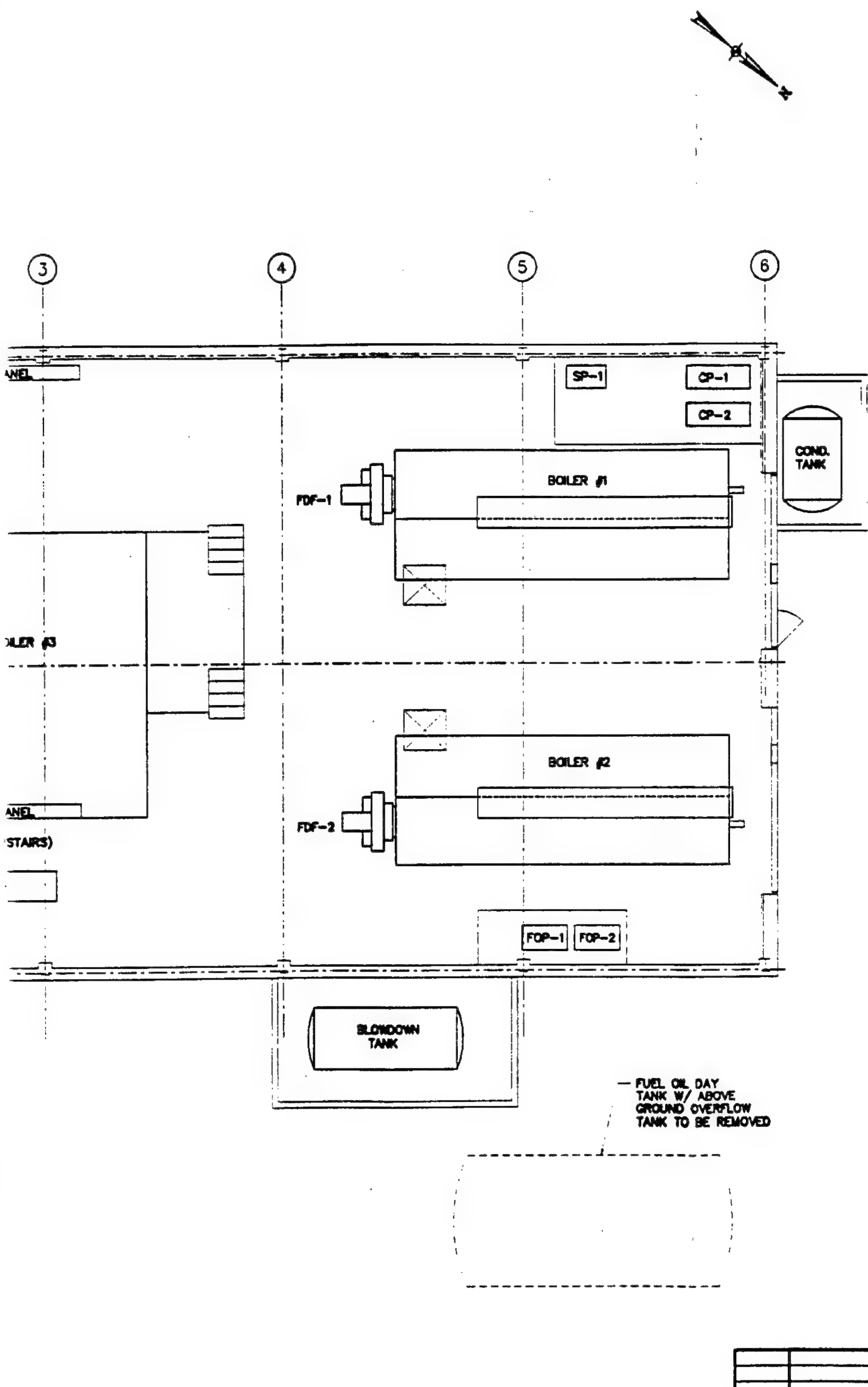
3

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REV | DATE | BY | CHKD | PM | APPD — REVISIONS

SEAL

DATE PRINTED

U.S. ARMY ENGINEER
DISTRICT, MOBILE/BALTIMORE

FORT DETRICK — FREDERICK, M.D.

FORT DERICK STUDY
BOILER PLANT – BUILDING 190
EQUIPMENT LAYOUT

ENTECH Engineering Inc.

| DATE | DRAWN BY | CHECKED BY | PROJ. MGR. | APPROVED |
|---|---|---|---|---|
| 3/22/95 | JNR | JED | JCE | |

| SCALE | PROJECT NO. | DRAWING NO. | REVISION |
|---|---|---|---|
| NONE | 4130.03 | FIG. 3.2.2 | [illegible] |

### 3.3 Steam Distribution

Steam is distributed to the buildings at Fort Detrick through an extensive piping system, consisting of pipe in underground tunnels, direct buried pipe, and overhead lines. Some of the overhead piping was installed to replace failed underground lines. The bulk of the piping remains in place either in tunnels or underground.

Steam leaves the boiler plant at a pressure of 110 psi through four different pipes. The three original mains, two (2) 10" and one (1) 8" pipe supply steam to all of the buildings on the Central System except Building 1425, USAMRIID, which has a separate 16 inch line that was installed around 1988. The line was intended to alleviate problems of inadequate steam pressure at the building.

There are numerous pressure reducing stations around the base, and they are primarily, located in manholes. These stations reduce the steam pressure to the level required by the buildings served from the manhole. Office buildings typically require only 10-15 psi steam for space heating and domestic hot water. Laboratories may require steam pressures at a minimum of 60-70 psi to operate autoclaves or other process equipment.

Condensate is returned from the distribution mains, and from applications and processes that are not considered hazardous. In the cases where steam or condensate is potentially exposed to hazardous materials, as with autoclaves, the condensate is then sent directly to the contaminated sewage system for process. Processes like the contaminated sewage treatment use direct injection and therefore do not create condensate for return.

The original installation allowed for the majority of the piping to be gravity feed to the condensate storage tank near the boiler plant. Subsequent changes to the piping due to re-design or condensate repairs has led to the increased use of condensate pump sets.

Condensate and steam piping leaks have been and will continue to be a problem. A number of repairs are presently in process for resolving such leaks. Condensate return numbers have progressively gotten better as these repairs are completed. In 1993, condensate levels dropped to around 25% at times. Leak resolution and some undetermined process changes have increased this total to over 40%.

It was estimated that the present breakdown of linear feet of piping aboveground, underground and within tunnels is as follows in Table 3.3.1.

**Steam and Condensate Piping Estimates (ft)**
**Table 3.3.1**

| Location | Percent | Steam | Condensate | Total |
|---|---|---|---|---|
| Aboveground | 35% | 15,050 | 18,200 | 33,250 |
| Underground | 10% | 4,300 | 5,200 | 9,500 |
| Tunnel | 55% | 23,650 | 28,600 | 52,250 |
| **Total** | **100%** | **43,000** | **52,000** | **95,000** |

The piping and insulation conditions can be summarized as follows. The newer aboveground steam and condensate is adequately insulated and in good shape. The underground piping is in poor condition with leaks continuing to develop as

The piping and insulation conditions can be summarized as follows. The newer aboveground steam and condensate is adequately insulated and in good shape. The underground piping is in poor condition with leaks continuing to develop as time passes. Its insulation is also considered in poor condition because of the evident browning of the grass above. The tunnel piping which includes the manholes is in fair to poor condition with some noticeable leaks from particular manholes. The insulation in many of the manholes is either in bad condition or completely off the piping. Insulation in the tunnel is assumed to be in similar condition, poor. A detailed study of this piping would be required to determine a scope for addressing these problems.

Attachment 8.8 contains a map of the steam distribution system. This information was gathered from existing zone maps provided by Fort Detrick's engineering office and from data collected by Entech during site visits. The map is intended to be an overview of the system layout and sizes.

## 3.4 Buildings

Most of the buildings connected to the Steam Distribution System are positioned between Rosemont Avenue (State Route 73) and Ditto Avenue. The buildings not served by the Steam Distribution System are either unheated, utilize an independent oil fired heating system, utilize an independent gas fired heating system, or have electric heat.

Table 3.4.1 lists the buildings connected to the Steam Distribution System. The building name, use, and estimated square footage is included in the table.

## FORT DETRICK
### FREDERICK, MARYLAND
### Table 3.4.1
### BUILDINGS USING STEAM

| Bldg. No. | Building Name | Building Use | Building SF | Comments |
|---|---|---|---|---|
| S-10 | Signal Service | Office | 4,600 | |
| S-11 | Thrift Shop | Store | 3,000 | |
| S-12 | Signal Service | Empty? | 1,000 | |
| S-100 | Outside Electric Shop | Warehouse/Shop/Office | 5,000 | |
| S-101 | Sewage Pump | | 800 | |
| S-122 | Rodent/Pest Control | Storage | 1,100 | |
| 190 | BOILER PLANT | | 11,200 | |
| S-199 | FE Mnt. Shop | Wharehouse/Shop | 12,100 | |
| 200 | | Equipment Shed | 1,200 | |
| S-201 | Engineering Offices | Offices | 25,300 | |
| T-239 | Cancer Research Center | Warehouse | 10,000 | |
| S-243 | Fe Sths | Warehouse/Shop | 6,600 | |
| S-244 | Cancer Research Center | Office | 5,100 | |
| T-248 | Cancer Research Center | Warehouse | 4,800 | |
| T-249 | Cancer Research Center | Warehouse | 4,800 | |
| S-261 | Radiology | Labratory | 2,500 | |
| S-262 | Gen. Storehouse | Warehouse | 5,000 | |
| S-263 | Fe Mnt Shop | Mech Shops/Storehouse | 13,900 | |
| S-312 | CRC – Fermentation Production Facility | | 400 | Fenced in with 313 |
| S-313 | CRC – Fermentation Production Facility | | 2,300 | |
| 314 | Cancer Research Center | Warehouse/Shop | 3,800 | |
| S-318 | | Warehouse | 3,300 | |
| S-319 | | Warehouse | 3,300 | |
| S-321 | Cancer Research Center | Office | 4,000 | Currently under construction |
| S-322 | Cancer Research Center | Office | 4,000 | |
| S-323 | Cancer Research Center | Warehouse | 3,300 | |
| S-324 | NCI-FCRF Central Supply & Trans | Warehouse | 7,500 | |
| S-325 | Cancer Research Center | Labratory | 12,800 | |
| 326 | USDA | Storage | 200 | |
| S-347 | Cancer Research Center | Chemical Storage | 2,000 | |
| 349 | Cancer Research Center | Office | 3,000 | |
| S-350 | Cancer Research Center | Office/Maintenance | 9,300 | |
| S-361 | Cancer Research Center | Maintenance Shop | 11,400 | |
| T-362 | Cancer Research Center | Office | 9,400 | |
| 374 | USDA | Lab | 18,400 | |
| 375 | Steam Sterilization Plant | Shop | 21,200 | |
| 376 | Cancer Research Center | Labratory | 31,300 | |
| 393 | Incinerator | Incinerator | 7,600 | |
| S-426 | CRC-Safety Protective Services | Offices/Med | 6,800 | |
| 427 | Cancer Research Center | Office | 6,000 | |
| 428 | Cancer Research Center | Office | 7,400 | |
| 429 | Cancer Research Center | Lab | 6,400 | |
| 430 | Cancer Research Center | Office | 6,000 | |
| 431 | Cancer Research Center | Lab | 12,000 | |
| S-432 | Cancer Research Center | Lab | 21,500 | |
| S-433 | Cancer Research Center | Lab | 5,800 | Replaced with a new lab |
| S-434 | CRC – Fermentation | Offices/Lab | 13,800 | |
| S-459 | Cancer Research Center | Warehouse/Shop | 10,200 | Undergoing major renov. |
| 469 | Cancer Research Center | Labratory | 56,100 | |
| 472 | Cancer Research Center | Labratory | 6,500 | Contains numerous tanks. |
| T-501 | Education/Library | Office | 7,600 | |
| S-504 | USAMRDC | Office | 9,800 | |
| S-505 | HQ USAMRDC | Office | 3,900 | |
| S-521 | Adm Gen Purp | Office | 11,500 | |
| S-522 | Cancer Research Center | Labratory | 13,000 | |
| S-524 | USAMBRDL Admin | Office | 5,300 | |
| S-525 | Adm Gen Purp | Office | 6,500 | |
| 538 | Cancer Research Center | Labratory | 64,200 | |

FORT DETRICK
FREDERICK, MARYLAND
Table 3.4.1
BUILDINGS USING STEAM

| Bldg. No. | Building Name | Building Use | Building SF | Comments |
|---|---|---|---|---|
| 539 | CRC–Leroy D. Fothergill Lab | Lab | 110,400 | |
| 549 | Cancer Research Center | Library | 15,000 | |
| 550 | Cancer Research Center | Labratory | 20,000 | |
| 560 | Cancer Research Center | Labratory | 170,000 | |
| 562 | Cancer Research Center | Labratory | 15,000 | |
| 567 | Cancer Research Center | Lab | 33,000 | |
| 568 | Biomedical R&D lab | Lab | 49,300 | |
| 571 | CRC–ANIMAL BUILDINGS | Labratory | 35,700 | |
| 576 | CRC–Biological Response Modifiers | Office | 2,200 | |
| T–611 | William Strough Auditorium | Auditorium w/stage | 5,200 | |
| S–660 | Visiting Officers Quarters | Residence | 12,200 | |
| T–701 | | Office | 2,000 | |
| T–703 | Fire Station | | 2,300 | |
| T–713 | Post Exchange | Post Exchange | 9,600 | |
| T–715 | Judge Advocate/Legal Assist DVQ Residenc | Office | 2,400 | |
| T–718 | Community Club | Community Club | 10,500 | |
| T–722 | Adm. Gen Purp. | Office | 9,600 | |
| T–817 | ASAMRAA | Office | 10,400 | |
| 810 | Administration | Office | 34,200 | |
| T–818 | Administration | | 2,000 | Connected to 817 |
| T–819 | ASAMRAA | Office | 1,400 | |
| T–820 | ASAMRAA | Office | 7,200 | Connnected to 817 |
| T–823 | Medical Logistics | Office | 2,100 | |
| T–824 | Medical Logistics | Office | 2,100 | |
| T–830 | Training Center | Office | 7,500 | |
| T–833 | Navy | Office | 6,700 | |
| T–834 | Navy | Office | 500 | Connected to 833 |
| T–835 | | Office | 1,600 | |
| T–838 | Field House | Field House/Gym | 13,400 | |
| S–839 | Fitness Center | Gym | 5,000 | |
| T–901 | Gen. Store House | Warehouse | 10,000 | |
| T–902 | Motor Pool | Office | 4,600 | |
| T–903 | Motor Pool | Office | 2,000 | |
| T–904 | Motor Pool | Office | 2,000 | |
| T–914 | PM Adm | Office | 3,700 | |
| 915 | Bowling Center | Bowling/Office | 5,000 | |
| T–921 | Car Wash/Auto Shop | Shop | 3,400 | |
| T–925 | Religious Education | Training/Education | 2,100 | |
| 949 | YOUTH CENTER | Youth Center | 5,200 | |
| 1021 | Cancer Research Center | Admin/Food Storage | 7,500 | |
| 1022–1049 | CRC–ANIMAL BUILDINGS | Animal Storage | 36,000 | |
| 1040 | CRC–ANIMAL BUILDINGS | Maintenance | 3,000 | |
| 1050 | Cancer Research Center | Warehouse/Offices | 40,000 | |
| 1054 | Medical Advance Tech Mgmnt | Office/Warehouse | 37,000 | |
| 1301 | USDA | Labs/Offices | 39,900 | |
| 1302 | USDA | Labs/Offices | 8,800 | Attached to 1301 |
| 1303 | USDA | Greenhouse | 3,700 | |
| 1304 | USDA | Greenhouse | 3,700 | |
| 1305 | USDA | Greenhouse | 3,700 | |
| 1306 | USDA | Greenhouse | 3,700 | |
| 1412 | USAMRIID ANNEX | Lab | 70,000 | |
| 1414 | USAMRIID ANNEX | Warehouse | 2,000 | |
| 1422 | DATA PROCESSING | Office | 11,200 | |
| 1425 | USAMRIID ANNEX | Lab | 224,100 | |
| 1430 | ENLISTED BARRACKS | Residence | 38,200 | |
| 1520 | Commisary | Commisary | 40,100 | |
| | | | 1,766,200 | |

## 4.0 BILLING HISTORIES

### 4.1 General

The energy analysis for this report is based upon data obtained for the 12 month period from January 1994 through December 1994. Information from 1993 is also included for comparison. The gas billing summarizes the direct costs associated with using gas for the boilers in the boiler plant. Additionally, natural gas and fuel oil usage, and boiler steam production totals are investigated in this section. This data was obtained from boiler logs maintained daily at the plant. To remain consistent and clear, Entech will use the information from the boiler logs to develop fuel to steam efficiencies, and for identifying usage trends and/or impact.

The billing associated with the electrical use is for the entire site. Electric usage meter readings for the boiler plant, as recorded by boiler plant personnel, are also included to complete the analysis.

### 4.2 Natural Gas

Fort Detrick uses natural gas in its boiler plant and in some of the site's buildings. For this report, the concern will only be for the natural gas used in the plant for making steam. The Frederick Gas Company supplies natural gas on an interruptible service for the boiler plant. Table 4.2.1 on the following page displays their billing history to the boiler plant for 1993 and 1994. Figure 4.2.2. graphically displays gas consumption for the last two years according to the Frederick Gas Company bills. Copies of the bills and the sales agreement for Fort Detrick can be referenced in Attachment 8.1.

## 1993/1994 Natural Gas Billing History
## Frederick Gas Company, Account #6000.001005
Table 4.2.1

1993 – Natural Gas Billing History

| Month | Total # Days | Usage (mcf) | Cost ($) | Ave. $/mcf | mcf/day | mmBtu |
|---|---|---|---|---|---|---|
| Jan | 29 | 22,220 | $85,534 | $3.85 | 766 | 22,887 |
| Feb | 31 | 21,030 | $81,033 | $3.85 | 678 | 21,661 |
| March | 30 | 37,010 | $142,607 | $3.85 | 1,234 | 38,120 |
| April | 30 | 74,820 | $288,012 | $3.85 | 2,494 | 77,065 |
| May | 28 | 53,150 | $231,516 | $4.36 | 1,898 | 54,745 |
| June | 33 | 55,730 | $242,754 | $4.36 | 1,689 | 57,402 |
| July | 30 | 50,080 | $174,849 | $3.49 | 1,669 | 51,582 |
| Aug | 32 | 51,760 | $180,715 | $3.49 | 1,618 | 53,313 |
| Sept | 30 | 55,070 | $214,776 | $3.90 | 1,836 | 56,722 |
| Oct | 29 | 59,560 | $208,975 | $3.51 | 2,054 | 61,347 |
| Nov | 30 | 78,620 | $277,206 | $3.53 | 2,621 | 80,979 |
| Dec | 30 | 39,700 | $156,208 | $3.93 | 1,323 | 40,891 |
| **Totals** | 362 | 598,750 | $2,284,185 | $3.81 | 1,654 | 616,713 |

1994 – Natural Gas Billing History

| Month | Total # Days | Usage (mcf) | Cost ($) | Ave. $/mcf | mcf/day | mmBtu |
|---|---|---|---|---|---|---|
| Jan | 32 | 18,802 | $73,621 | $3.92 | 588 | 19,366 |
| Feb | 28 | 33,527 | $132,832 | $3.96 | 1,197 | 34,533 |
| March | 31 | 90,567 | $356,005 | $3.93 | 2,922 | 93,284 |
| April | 29 | 66,430 | $240,306 | $3.62 | 2,291 | 68,423 |
| May | 32 | 63,276 | $229,123 | $3.62 | 1,977 | 65,174 |
| June | 30 | 46,638 | $168,544 | $3.61 | 1,555 | 48,037 |
| July | 29 | 43,694 | $158,215 | $3.62 | 1,507 | 45,005 |
| Aug | 33 | 53,261 | $170,960 | $3.21 | 1,614 | 54,859 |
| Sept | 30 | 50,118 | $160,083 | $3.19 | 1,671 | 51,622 |
| Oct | 31 | 60,033 | $192,508 | $3.21 | 1,937 | 61,834 |
| Nov | 30 | 68,437 | $219,457 | $3.21 | 2,281 | 70,490 |
| Dec | 30 | 13,885 | $44,481 | $3.20 | 463 | 14,302 |
| **Totals** | 365 | 608,668 | $2,146,135 | $3.53 | 1,668 | 626,928 |

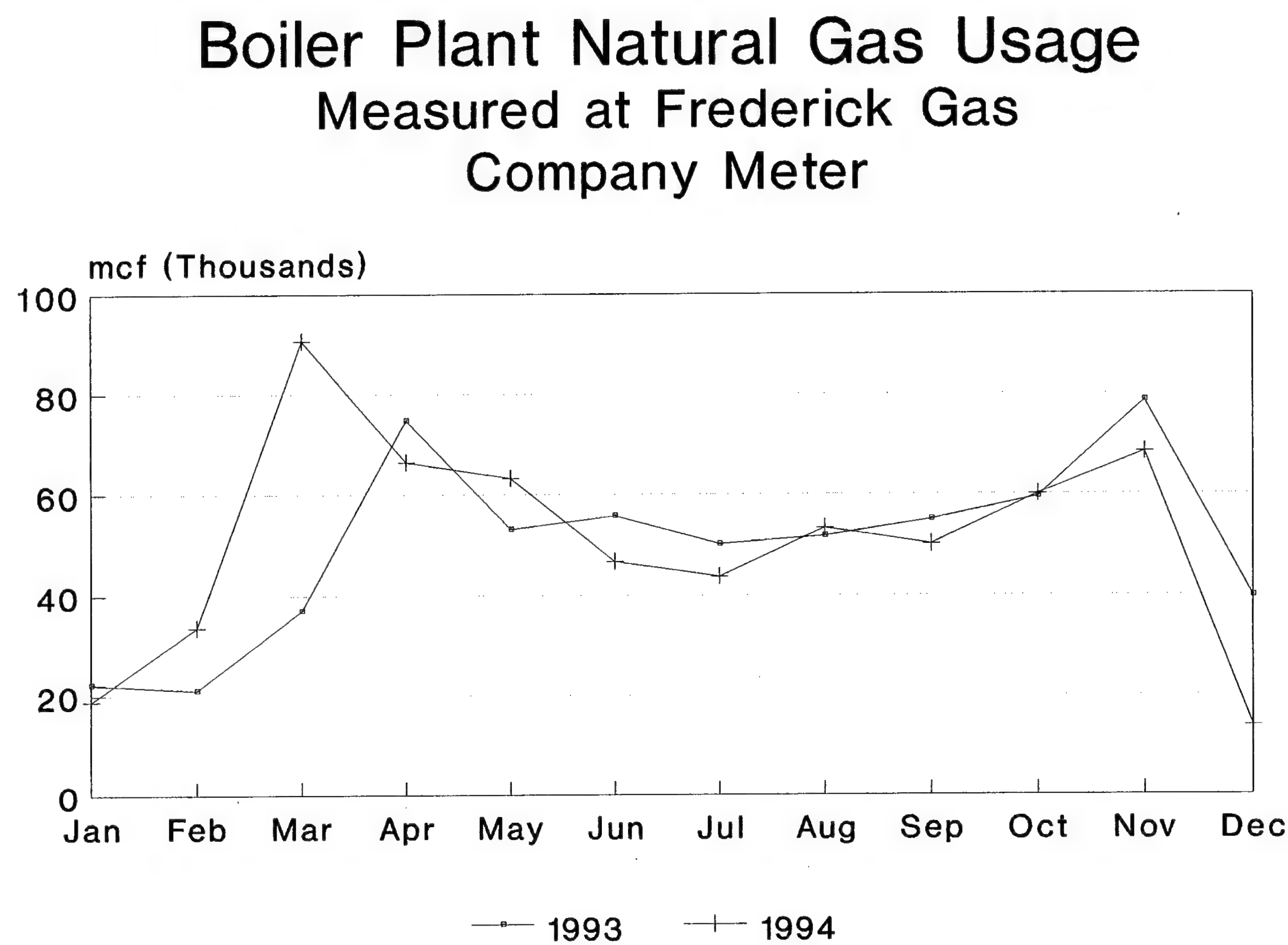

Boiler Plant Natural Gas Usage
Measured at Frederick Gas
Company Meter
mcf (Thousands)
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
1993
1994

Figure 4.2.2

As previously stated, the natural gas usage history from the Boiler Plant daily logs was accumulated for each boiler. This information is shown graphically in Figure 4.2.3, for 1994 and it is also Tabulated in Table 4.2.4 for 1993 and 1994. Natural gas used for banking ~~by each~~ boiler is identified separately in Table 4.2.5. Banking is the practice of utilizing fuel for maintaining drum pressure in a boiler while on standby. Figure 4.2.6 compares the total usage trends for 1993 and 1994. Again, the boiler log data will be used for determining efficiencies, and savings where applicable.

?

# 1994 Natural Gas Usage
## Boiler #1 thru #6
## Measured in Boiler Plant

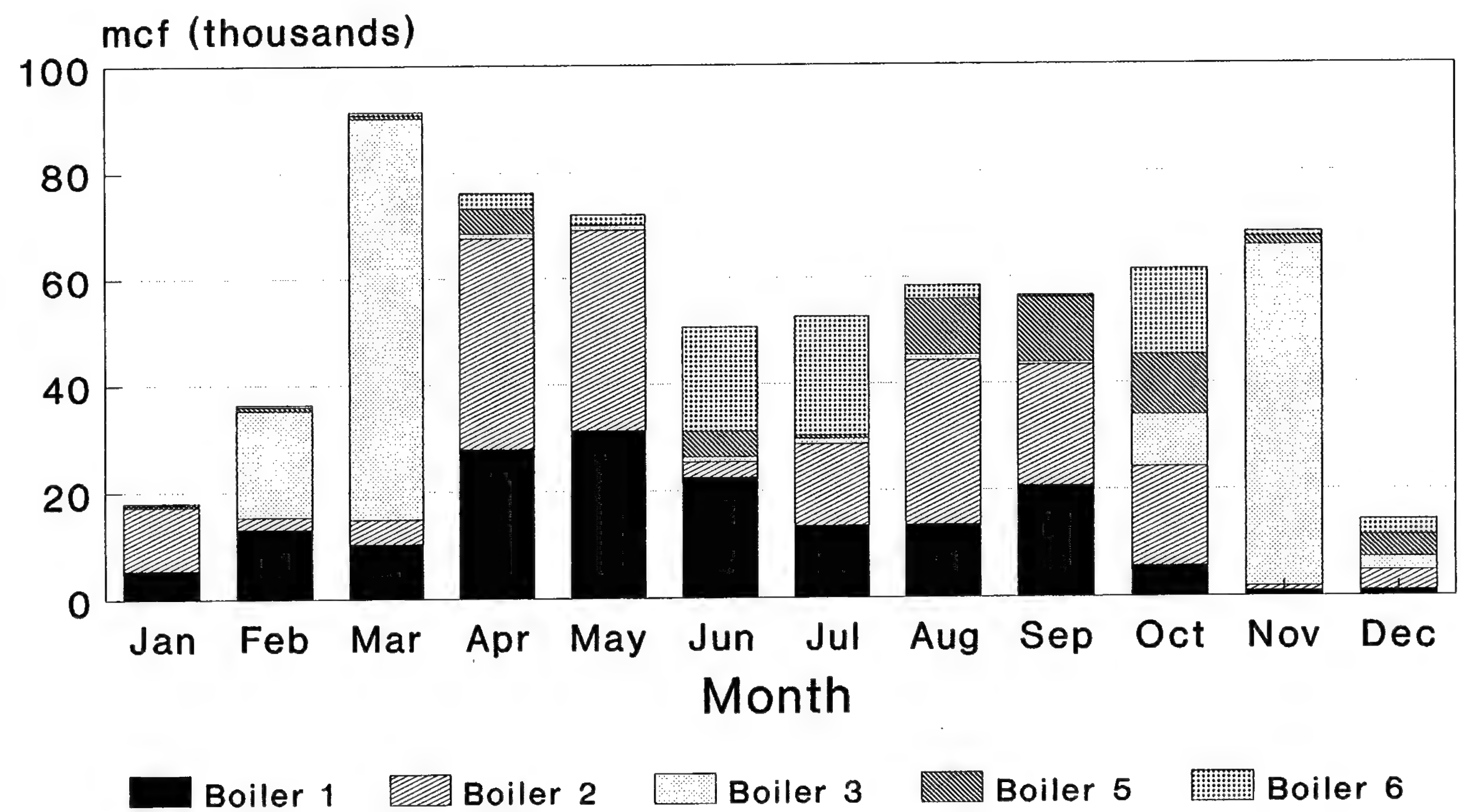



Figure 4.2.3

## 1993/1994 Natural Gas Usage
## Log Data – Boilers #1 thru #6
Table 4.2.4

### 1993 – Natural Gas Usage

| Month | Total # Days | Boiler # 1 (mcf) | Boiler # 2 (mcf) | Boiler # 3 (mcf) | Boiler # 5 (mcf) | Boiler # 6 (mcf) | Total (mcf) | Gas to Steam or Banking | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Steam (mcf) | Bank (mcf) | Bank (%) |
| Jan | 31 | 2,673 | 2,513 | 0 | 832 | 15,569 | 21,587 | 20,472 | 1,115 | 5.2% |
| Feb | 28 | 198 | 198 | 0 | 1,342 | 16,593 | 18,332 | 17,552 | 780 | 4.3% |
| March | 31 | 3,255 | 1,104 | 25,914 | 594 | 9,173 | 40,041 | 39,010 | 1,031 | 2.6% |
| April | 30 | 13,312 | 12,261 | 40,970 | 413 | 8,886 | 75,842 | 74,473 | 1,368 | 1.8% |
| May | 31 | 2,316 | 2,555 | 34,472 | 9,675 | 11,266 | 60,284 | 58,814 | 1,471 | 2.4% |
| June | 30 | 12,619 | 13,321 | 942 | 14,724 | 14,320 | 55,926 | 54,564 | 1,363 | 2.4% |
| July | 31 | 5,418 | 5,197 | 241 | 21,846 | 21,827 | 54,529 | 53,690 | 839 | 1.5% |
| Aug | 31 | 14,304 | 14,774 | 733 | 12,888 | 13,178 | 55,877 | 54,451 | 1,426 | 2.6% |
| Sept | 30 | 303 | 810 | 857 | 27,543 | 27,474 | 56,987 | 55,809 | 1,178 | 2.1% |
| Oct | 31 | 17,792 | 16,678 | 27,241 | 5,210 | 4,128 | 71,049 | 69,553 | 1,496 | 2.1% |
| Nov | 30 | 29,170 | 35,375 | 905 | 13,079 | 7,482 | 86,012 | 84,541 | 1,471 | 1.7% |
| Dec | 31 | 20,182 | 17,726 | 353 | 9,196 | 566 | 48,024 | 46,598 | 1,425 | 3.0% |
| **Totals** | 365 | 121,543 | 122,512 | 132,628 | 117,343 | 150,462 | 644,489 | 629,527 | 14,963 | N/A |
| Average | 30 | 10,129 | 10,209 | 11,052 | 9,779 | 12,539 | 53,707 | 52,461 | 1,247 | 2.3% |
| **% of Tot.** | N/A | 18.9% | 19.0% | 20.6% | 18.2% | 23.3% | 100.0% | 97.7% | 2.3% | N/A |

### 1994 – Natural Gas Usage

| Month | Total # Days | Boiler # 1 (mcf) | Boiler # 2 (mcf) | Boiler # 3 (mcf) | Boiler # 5 (mcf) | Boiler # 6 (mcf) | Total (mcf) | Gas to Steam or Banking | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Steam (mcf) | Bank (mcf) | Bank (%) |
| Jan | 31 | 5,429 | 11,935 | 0 | 344 | 353 | 18,061 | 17,186 | 875 | 4.8% |
| Feb | 28 | 13,138 | 2,286 | 19,905 | 742 | 358 | 36,428 | 35,763 | 666 | 1.8% |
| March | 31 | 10,427 | 4,474 | 75,322 | 533 | 570 | 91,325 | 89,926 | 1,400 | 1.5% |
| April | 30 | 27,983 | 39,617 | 943 | 4,669 | 2,940 | 76,152 | 74,708 | 1,444 | 1.9% |
| May | 31 | 31,343 | 37,754 | 1,011 | 95 | 1,890 | 72,092 | 70,518 | 1,574 | 2.2% |
| June | 30 | 22,556 | 2,801 | 1,052 | 4,742 | 19,582 | 50,733 | 49,100 | 1,634 | 3.2% |
| July | 31 | 13,576 | 15,119 | 1,007 | 562 | 22,361 | 52,624 | 50,982 | 1,642 | 3.1% |
| Aug | 31 | 13,610 | 30,728 | 1,016 | 10,507 | 2,587 | 58,449 | 56,843 | 1,606 | 2.7% |
| Sept | 30 | 20,738 | 22,660 | 482 | 12,152 | 431 | 56,463 | 55,160 | 1,303 | 2.3% |
| Oct | 31 | 5,722 | 18,507 | 9,702 | 11,265 | 16,249 | 61,444 | 60,661 | 783 | 1.3% |
| Nov | 30 | 927 | 1,001 | 63,968 | 1,622 | 948 | 68,467 | 66,739 | 1,728 | 2.5% |
| Dec | 31 | 1,107 | 3,668 | 2,540 | 4,111 | 2,873 | 14,298 | 13,028 | 1,270 | 8.9% |
| **Totals** | 365 | 166,556 | 190,549 | 176,947 | 51,345 | 71,140 | 656,537 | 640,613 | 15,924 | N/A |
| Average | 30 | 13,880 | 15,879 | 14,746 | 4,279 | 5,928 | 54,711 | 53,384 | 1,327 | 2.4% |
| **% of Tot.** | N/A | 25.4% | 29.0% | 27.0% | 7.8% | 10.8% | 100.0% | 97.6% | 2.4% | N/A |

## 1993/1994 Natural Gas Banking Totals

## Log Data – Boilers #1 thru #6

Table 4.2.5

1993 – Natural Gas Banking

| Month | Total # Days | Boiler # 1 (mcf) | Boiler # 2 (mcf) | Boiler # 3 (mcf) | Boiler # 5 (mcf) | Boiler # 6 (mcf) | Total (mcf) |
|---|---|---|---|---|---|---|---|
| Jan | 31 | 208 | 235 | 0 | 512 | 160 | 1,115 |
| Feb | 28 | 198 | 198 | 0 | 384 | 0 | 780 |
| March | 31 | 240 | 205 | 0 | 400 | 186 | 1,031 |
| April | 30 | 105 | 82 | 439 | 413 | 330 | 1,368 |
| May | 31 | 258 | 261 | 307 | 282 | 363 | 1,471 |
| June | 30 | 149 | 142 | 808 | 225 | 39 | 1,363 |
| July | 31 | 214 | 208 | 241 | 85 | 91 | 839 |
| Aug | 31 | 30 | 142 | 733 | 259 | 262 | 1,426 |
| Sept | 30 | 221 | 100 | 857 | 0 | 0 | 1,178 |
| Oct | 31 | 111 | 112 | 546 | 313 | 414 | 1,496 |
| Nov | 30 | 0 | 0 | 905 | 195 | 371 | 1,471 |
| Dec | 31 | 31 | 154 | 353 | 322 | 566 | 1,425 |
| **Totals** | 365 | 1,763 | 1,839 | 5,189 | 3,391 | 2,782 | 14,963 |
| Average | 30 | 147 | 153 | 432 | 283 | 232 | 1,247 |
| **% of Tot.** | N/A | 11.8% | 12.3% | 34.7% | 22.7% | 18.6% | 100.0% |

1994 – Natural Gas Banking

| Month | Total # Days | Boiler # 1 (mcf) | Boiler # 2 (mcf) | Boiler # 3 (mcf) | Boiler # 5 (mcf) | Boiler # 6 (mcf) | Total (mcf) |
|---|---|---|---|---|---|---|---|
| Jan | 31 | 117 | 61 | 0 | 344 | 353 | 875 |
| Feb | 28 | 25 | 112 | 0 | 252 | 277 | 666 |
| March | 31 | 147 | 150 | 0 | 533 | 570 | 1,400 |
| April | 30 | 14 | 0 | 943 | 103 | 385 | 1,444 |
| May | 31 | 0 | 0 | 1,011 | 95 | 468 | 1,574 |
| June | 30 | 72 | 0 | 1,052 | 429 | 82 | 1,634 |
| July | 31 | 49 | 25 | 1,007 | 562 | 0 | 1,642 |
| Aug | 31 | 117 | 0 | 1,016 | 315 | 157 | 1,606 |
| Sept | 30 | 47 | 42 | 482 | 302 | 431 | 1,303 |
| Oct | 31 | 169 | 69 | 116 | 222 | 208 | 783 |
| Nov | 30 | 211 | 274 | 0 | 610 | 633 | 1,728 |
| Dec | 31 | 220 | 137 | 90 | 352 | 472 | 1,270 |
| **Totals** | 365 | 1,185 | 870 | 5,716 | 4,119 | 4,035 | 15,924 |
| Average | 30 | 99 | 72 | 476 | 343 | 336 | 1,327 |
| **% of Tot.** | N/A | 7.4% | 5.5% | 35.9% | 25.9% | 25.3% | 100.0% |

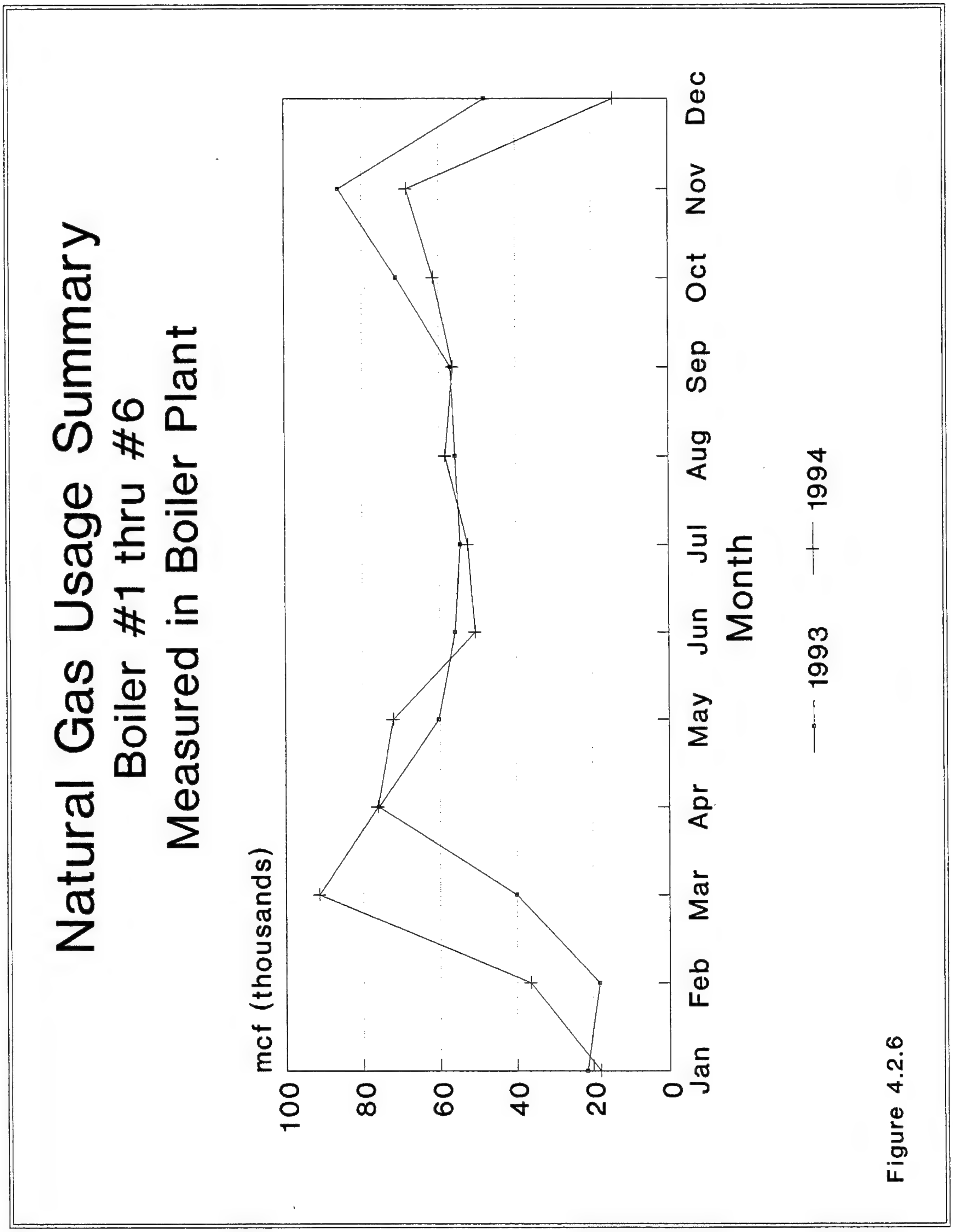

Natural Gas Usage Summary
Boiler #1 thru #6
Measured in Boiler Plant
mcf (thousands)
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
1993
1994

Figure 4.2.6

During the auditing of the billing and usage histories, discrepancies were determined between the billing data and the boiler log data for natural gas. A graphical comparison of the two is shown in Figure 4.2.7 for 1994. An additional comparison is done in Table 4.2.8. In this table ratios are used in an attempt to derive trends which might aid in determining the differences.

The trend evident in Figure 4.2.7 shows that the largest discrepancies in 1994 occurred in the months from April through September. Identifying the actual cause for these discrepancies from analyzing Figures 4.2.5 or 4.2.6 would only be speculative. Further evaluation of both sets of data has led Entech to use the boiler log information for determining efficiencies and/or savings. These will be shown, and discussed later in the report.

As for the costs, the $3.53/mcf unit cost, determined from the Frederick Gas Company billings, will be used when calculating savings with individuals ECOs.

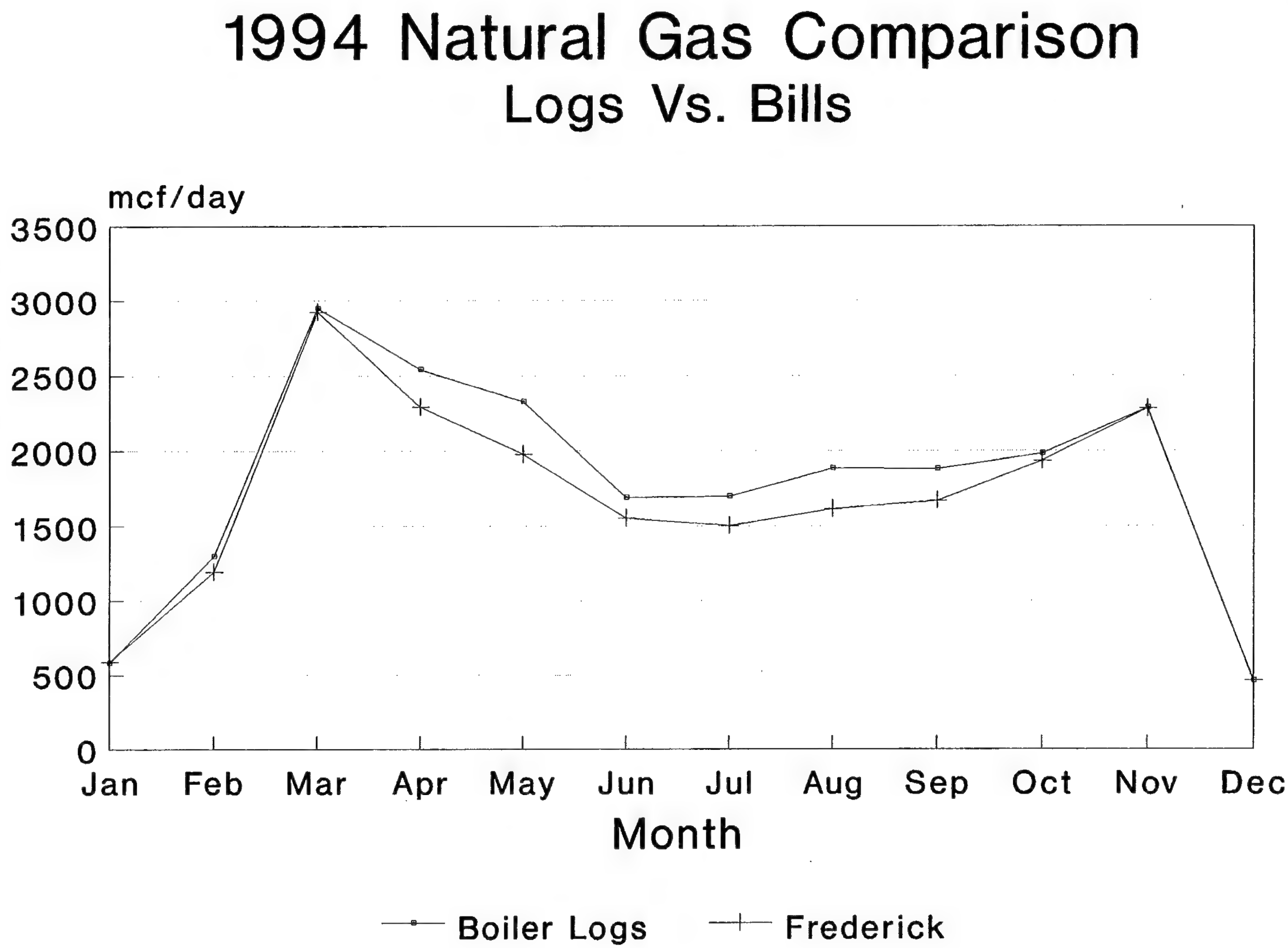

1994 Natural Gas Comparison
Logs Vs. Bills
mcf/day
3500
3000
2500
2000
1500
1000
500
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Boiler Logs
Frederick

Figure 4.2.7

## GAS USAGE COMPARSION
## Table 4.2.8

### 1993 BOILER LOGS/FREDERICK LOGS

| Month | Boiler Logs | | | Frederick Bills | | | Diff. Totals | | Ratio |
|---|---|---|---|---|---|---|---|---|---|
| | Total # Days | 1993 Totals(mcf) | 1993 (mcf/day) | Total # Days | 1993 Totals(mcf) | 1993 (mcf/day) | 1993 Totals(mcf) | 1993 (mcf/day) | 1993 (mcf/day) |
| Jan | 31 | 21,587 | 696 | 29 | 22,220 | 766 | (633) | (70) | 0.91 |
| Feb | 28 | 18,332 | 655 | 31 | 21,030 | 678 | (2,698) | (24) | 0.97 |
| March | 31 | 40,041 | 1,292 | 30 | 37,010 | 1,234 | 3,031 | 58 | 1.05 |
| April | 30 | 75,842 | 2,528 | 30 | 74,820 | 2,494 | 1,022 | 34 | 1.01 |
| May | 31 | 60,284 | 1,945 | 28 | 53,150 | 1,898 | 7,134 | 46 | 1.02 |
| June | 30 | 55,926 | 1,864 | 33 | 55,730 | 1,689 | 196 | 175 | 1.10 |
| July | 31 | 54,529 | 1,759 | 30 | 50,080 | 1,669 | 4,449 | 90 | 1.05 |
| Aug | 31 | 55,877 | 1,802 | 32 | 51,760 | 1,618 | 4,117 | 185 | 1.11 |
| Sept | 30 | 56,987 | 1,900 | 30 | 55,070 | 1,836 | 1,917 | 64 | 1.03 |
| Oct | 31 | 71,049 | 2,292 | 29 | 59,560 | 2,054 | 11,489 | 238 | 1.12 |
| Nov | 30 | 86,012 | 2,867 | 30 | 78,620 | 2,621 | 7,392 | 246 | 1.09 |
| Dec | 31 | 48,024 | 1,549 | 30 | 39,700 | 1,323 | 8,324 | 226 | 1.17 |
| **Totals** | 365 | 644,489 | 21,149 | 362 | 598,750 | 19,880 | 45,739 | 1,269 | 1.06 |
| **Average** | 30.42 | 53,707 | 1,762 | 30.17 | 49,896 | 1,657 | 3,812 | 106 | 1.06 |

### 1994 BOILER LOGS/FREDERICK LOGS

| Month | Boiler Logs | | | Frederick Bills | | | Diff. Totals | | Ratio |
|---|---|---|---|---|---|---|---|---|---|
| | Total # Days | 1994 Totals(mcf) | 1994 (mcf/day) | Total # Days | 1994 Totals(mcf) | 1994 (mcf/day) | 1994 Totals(mcf) | 1994 (mcf/day) | 1994 (mcf/day) |
| Jan | 31 | 18,061 | 583 | 32 | 18,803 | 588 | (742) | (5) | 0.99 |
| Feb | 28 | 36,428 | 1,301 | 28 | 33,527 | 1,197 | 2,901 | 104 | 1.09 |
| March | 31 | 91,325 | 2,946 | 31 | 90,567 | 2,922 | 759 | 24 | 1.01 |
| April | 30 | 76,152 | 2,538 | 29 | 66,430 | 2,291 | 9,722 | 248 | 1.11 |
| May | 31 | 72,092 | 2,326 | 32 | 63,276 | 1,977 | 8,816 | 348 | 1.18 |
| June | 30 | 50,733 | 1,691 | 30 | 46,638 | 1,555 | 4,096 | 137 | 1.09 |
| July | 31 | 52,624 | 1,698 | 29 | 43,694 | 1,507 | 8,930 | 191 | 1.13 |
| Aug | 31 | 58,449 | 1,885 | 33 | 53,261 | 1,614 | 5,188 | 271 | 1.17 |
| Sept | 30 | 56,463 | 1,882 | 30 | 50,118 | 1,671 | 6,345 | 211 | 1.13 |
| Oct | 31 | 61,444 | 1,982 | 31 | 60,033 | 1,937 | 1,411 | 46 | 1.02 |
| Nov | 30 | 68,467 | 2,282 | 30 | 68,437 | 2,281 | 30 | 1 | 1.00 |
| Dec | 31 | 14,298 | 461 | 30 | 13,885 | 463 | 414 | (2) | 1.00 |
| **Totals** | 365 | 656,537 | 21,575 | 365 | 608,669 | 20,001 | 47,868 | 1,574 | 1.08 |
| **Average** | 30.42 | 54,711 | 1,798 | 30.42 | 50,722 | 1,667 | 3,989 | 131 | 1.08 |

## 4.3 Fuel Oil

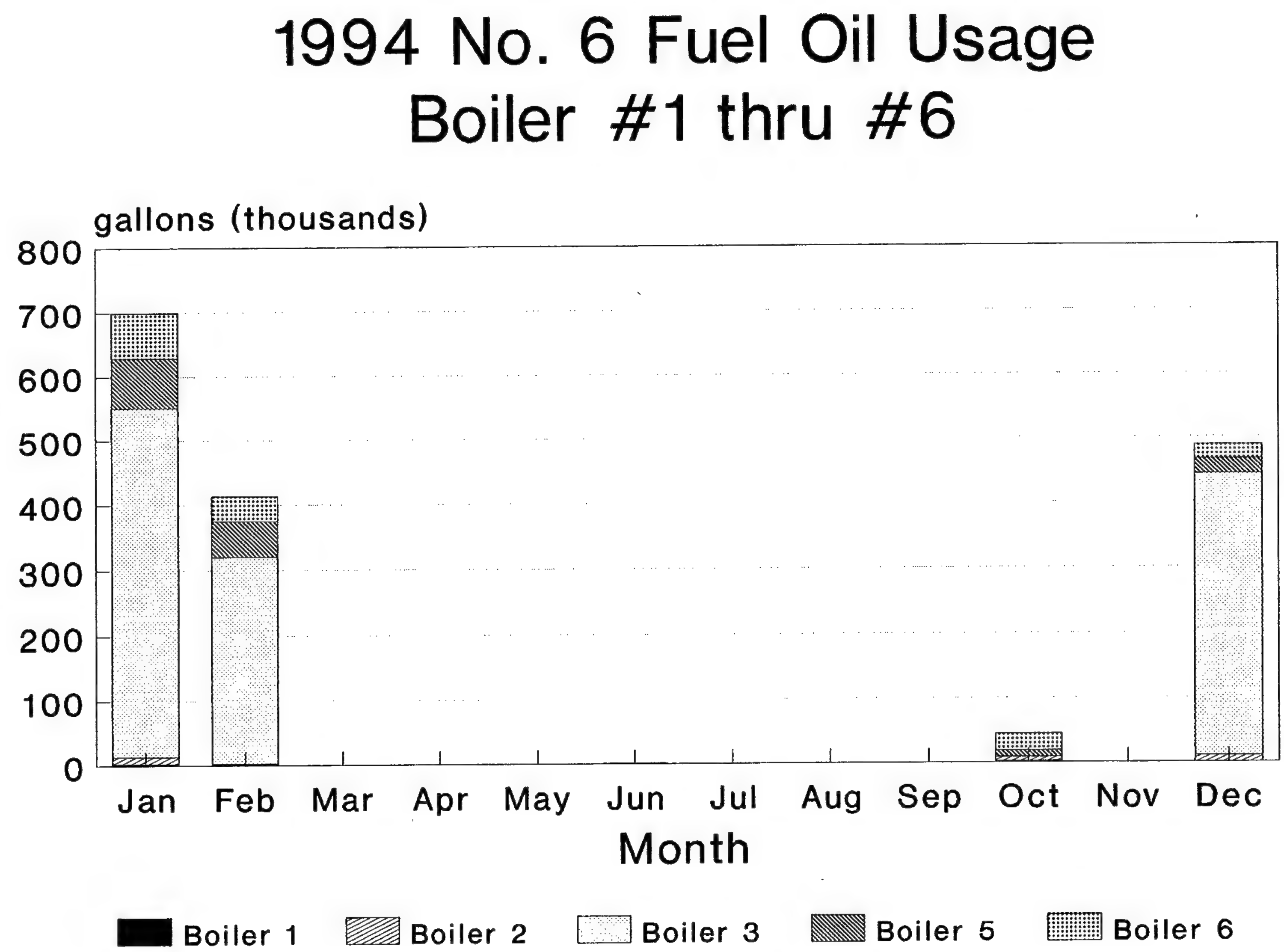
Fort Detrick utilizes No. 6 fuel oil as a secondary fuel for steam production. According to Fort Detrick facility personnel, the incremental cost of purchasing No. 6 fuel oil from the Defense Fuel Supply Center is $0.42 per gallon. This value will be used when determining ECO cost savings.

The Boiler Plant daily log data is the source for tracking the history of No. 6 fuel oil use Table 4.3.1 totals the usage and costs for 1994. Figure 4.3.2 graphically displays the individual boiler usage for 1994, and Table 4.3.3 summarizes the monthly information for 1993 and 1994 by boiler. Table 4.3.4 reflects the fuel oil used for banking. Figure 4.3.5 graphically compares the two years.

Frederick Gas Company allows Fort Detrick to be on the interruptible rate as long as a significant part of the steam load in the winter is fired by fuel oil. The boiler plant operators accomplish this by base loading Boiler No. 3, the largest boiler, on No. 6 fuel oil from December to March.

**No. 6 Fuel Oil**
**1994 Usage and Cost Summary**
**Figure 4.3.1**

| Month | Gallons | Cost |
|---|---|---|
| January | 699,269 | $293,700 |
| February | 413,326 | $173,600 |
| March | 0 | $0 |
| April | 0 | $0 |
| May | 0 | $0 |
| June | 524 | $220 |
| July | 0 | $0 |
| August | 0 | $0 |
| September | 0 | $0 |
| October | 44,476 | $18,680 |
| November | 0 | $0 |
| December | 487,976 | $204,950 |
| **Total** | **1,645,571** | **$691,150** |



1994 No. 6 Fuel Oil Usage
Boiler #1 thru #6
gallons (thousands)
800
700
600
500
400
300
200
100
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Boiler 1
Boiler 2
Boiler 3
Boiler 5
Boiler 6


Figure 4.3.2

## 1993/1994 No. 6 Oil Usage
## Log Data – Boilers #1 thru #6
Table 4.3.3

1993 – No. 6 Oil Usage

| Month | Total # Days | Boiler # 1 (gal) | Boiler # 2 (gal) | Boiler # 3 (gal) | Boiler # 5 (gal) | Boiler # 6 (gal) | Total (gal) | Oil to Steam or Banking | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Steam (gal) | Bank (gal) | Bank (%) |
| Jan | 31 | 0 | 0 | 497,929 | 0 | 0 | 497,929 | 497,929 | 0 | 0.0% |
| Feb | 28 | 13,395 | 10,506 | 508,519 | 1,150 | 12,405 | 545,975 | 543,767 | 2,208 | 0.4% |
| March | 31 | 814 | 33,072 | 312,982 | 1,238 | 21,166 | 369,272 | 366,959 | 2,313 | 0.6% |
| April | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| May | 31 | 0 | 0 | 23,512 | 0 | 0 | 23,512 | 23,482 | 30 | 0.1% |
| June | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| July | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Aug | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Sept | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Oct | 31 | 250 | 274 | 0 | 11,359 | 16,313 | 28,196 | 27,188 | 1,008 | 3.6% |
| Nov | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Dec | 31 | 0 | 0 | 353,891 | 7,970 | 7,830 | 369,691 | 369,691 | 0 | 0.0% |
| **Totals** | 365 | 14,459 | 43,852 | 1,696,833 | 21,717 | 57,714 | 1,834,575 | 1,829,016 | 5,559 | N/A |
| Average | 30 | 1,205 | 3,654 | 141,403 | 1,810 | 4,810 | 152,881 | 152,418 | 463 | 0.3% |
| **% of Tot.** | N/A | 0.8% | 2.4% | 92.5% | 1.2% | 3.1% | 100.0% | 99.7% | 0.3% | N/A |

1994 – No. 6 Oil Usage

| Month | Total # Days | Boiler # 1 (gal) | Boiler # 2 (gal) | Boiler # 3 (gal) | Boiler # 5 (gal) | Boiler # 6 (gal) | Total (gal) | Oil to Steam or Banking | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Steam (gal) | Bank (gal) | Bank (%) |
| Jan | 31 | 2,470 | 11,420 | 537,103 | 77,777 | 70,499 | 699,269 | 696,498 | 2,771 | 0.4% |
| Feb | 28 | 1,430 | 1,375 | 317,595 | 54,822 | 38,104 | 413,326 | 409,470 | 3,856 | 0.9% |
| March | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| April | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| May | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| June | 30 | 0 | 0 | 0 | 524 | 0 | 524 | 524 | 0 | 0.0% |
| July | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Aug | 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Sept | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Oct | 31 | 1,682 | 7,020 | 0 | 9,576 | 26,198 | 44,476 | 44,446 | 30 | 0.1% |
| Nov | 30 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Dec | 31 | 0 | 9,760 | 433,595 | 22,078 | 22,543 | 487,976 | 487,922 | 54 | 0.0% |
| **Totals** | 365 | 5,582 | 29,575 | 1,288,293 | 164,777 | 157,344 | 1,645,571 | 1,638,860 | 6,711 | N/A |
| Average | 30 | 465 | 2,465 | 107,358 | 13,731 | 13,112 | 137,131 | 136,572 | 559 | 0.4% |
| **% of Tot.** | N/A | 0.3% | 1.8% | 78.3% | 10.0% | 9.6% | 100.0% | 99.6% | 0.4% | N/A |

## 1993/1994 No. 6 Oil Banking
## Log Data – Boilers #1 thru #6

Table 4.3.4

1993 – No. 6 Oil Banking

| Month | Total # Days | Boiler # 1 (gal) | Boiler # 2 (gal) | Boiler # 3 (gal) | Boiler # 5 (gal) | Boiler # 6 (gal) | Total (gal) |
|---|---|---|---|---|---|---|---|
| Jan | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| Feb | 28 | 255 | 244 | 0 | 1,150 | 559 | 2,208 |
| March | 31 | 814 | 0 | 0 | 1,238 | 261 | 2,313 |
| April | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| May | 31 | 0 | 0 | 30 | 0 | 0 | 30 |
| June | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| July | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aug | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sept | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct | 31 | 250 | 274 | 0 | 484 | 0 | 1,008 |
| Nov | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dec | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Totals** | 365 | 1,319 | 518 | 30 | 2,872 | 820 | 5,559 |
| Average | 30 | 110 | 43 | 3 | 239 | 68 | 463 |
| **% of Tot.** | N/A | 23.7% | 9.3% | 0.5% | 51.7% | 14.8% | 100.0% |

1994 – No. 6 Oil Banking

| Month | Total # Days | Boiler # 1 (gal) | Boiler # 2 (gal) | Boiler # 3 (gal) | Boiler # 5 (gal) | Boiler # 6 (gal) | Total (gal) |
|---|---|---|---|---|---|---|---|
| Jan | 31 | 1,505 | 1,230 | 0 | 14 | 22 | 2,771 |
| Feb | 28 | 1,430 | 1,375 | 0 | 323 | 728 | 3,856 |
| March | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| April | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| May | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| June | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| July | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| Aug | 31 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sept | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| Oct | 31 | 30 | 0 | 0 | 0 | 0 | 30 |
| Nov | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| Dec | 31 | 0 | 0 | 54 | 0 | 0 | 54 |
| **Totals** | 365 | 2,965 | 2,605 | 54 | 337 | 750 | 6,711 |
| Average | 30 | 247 | 217 | 5 | 28 | 63 | 559 |
| **% of Tot.** | N/A | 44.2% | 38.8% | 0.8% | 5.0% | 11.2% | 100.0% |

No. 6 Fuel Oil Usage Summary
Boiler #1 thru #6
Measured in Boiler Plant

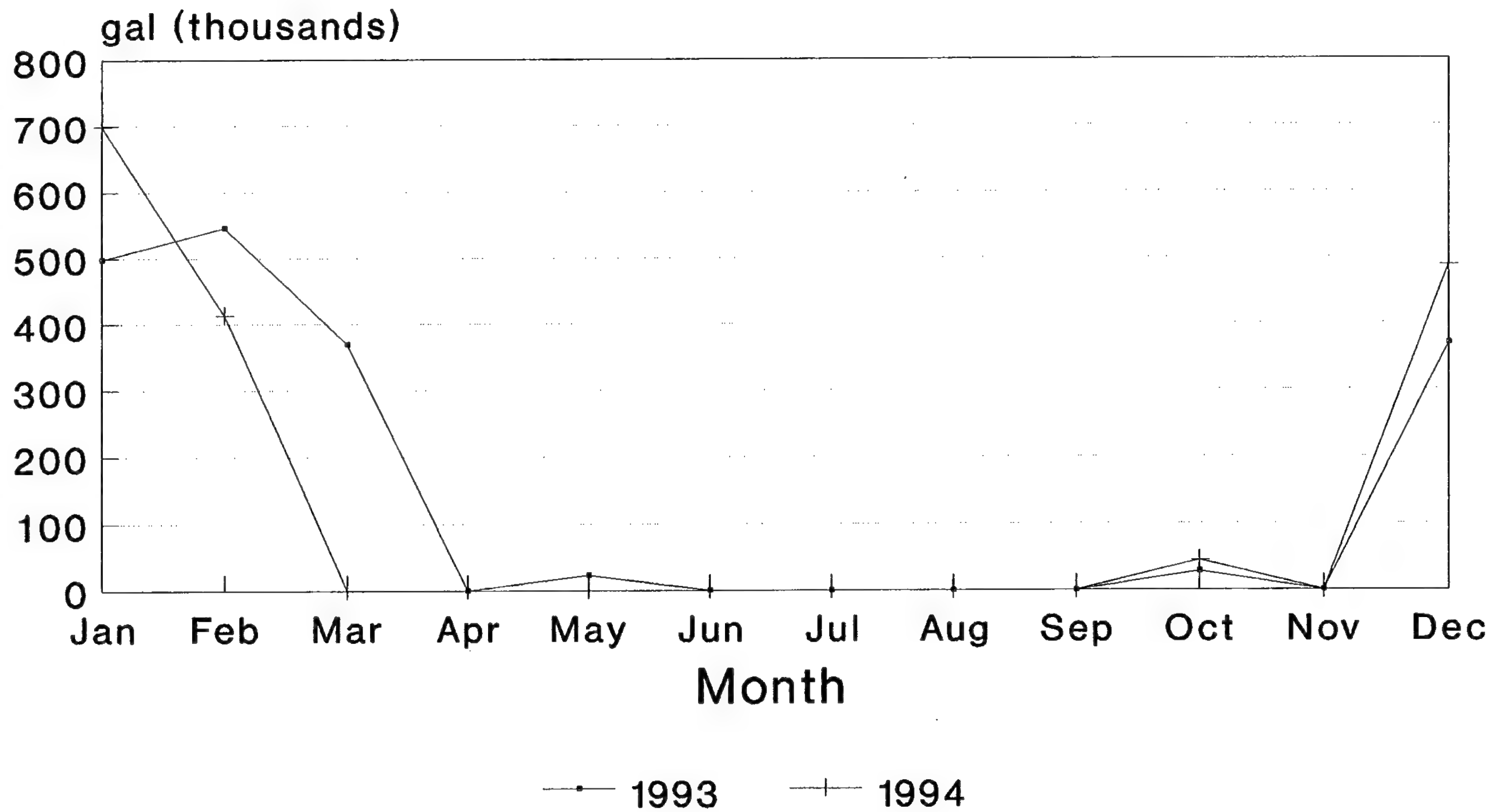
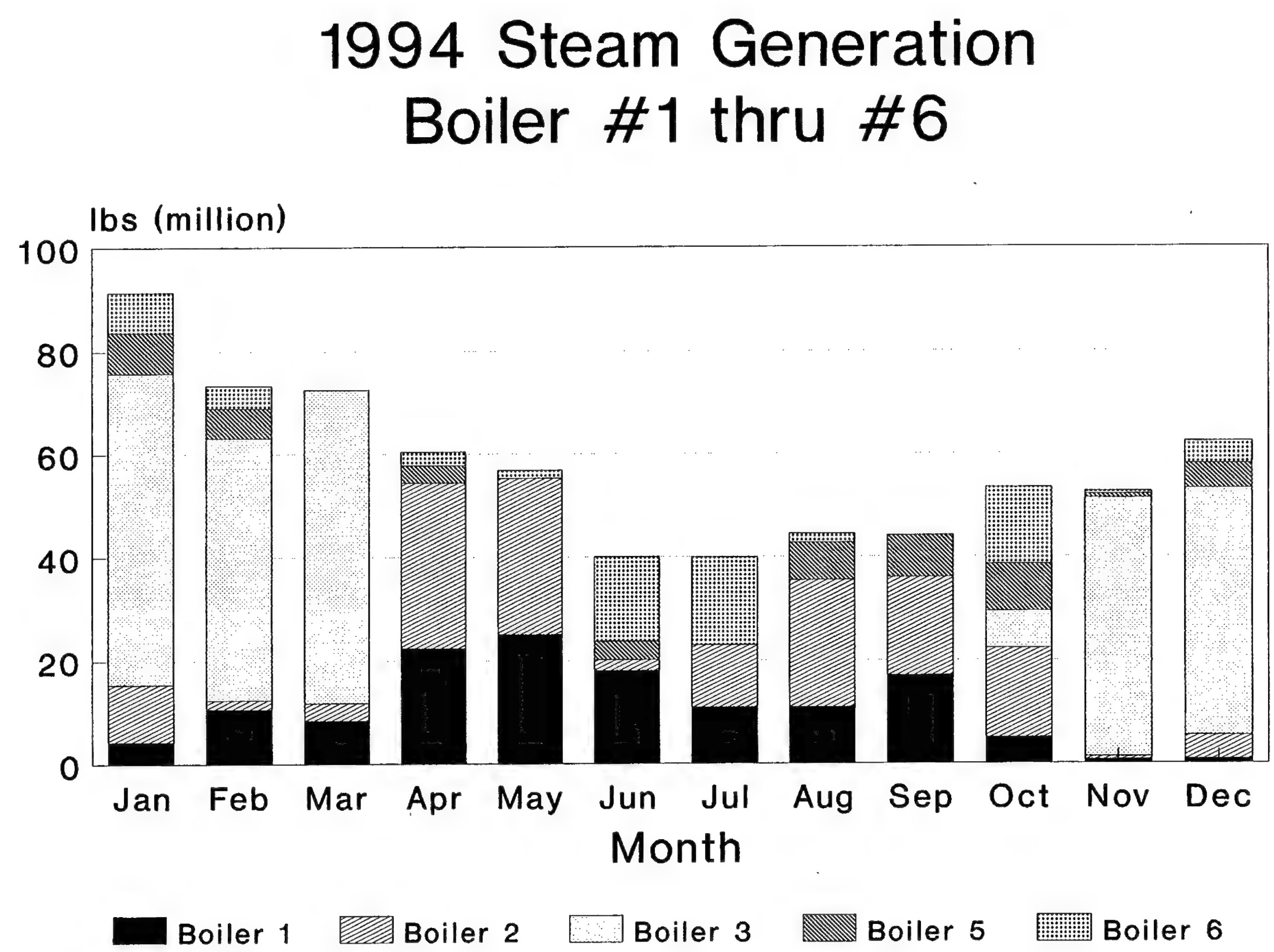



Figure 4.3.5

## 4.4 Steam Production

The boiler plant provides steam to the Fort Detrick Army Facilities and the National Cancer Institute (NCI) facilities located within the site perimeter. Like natural gas and fuel oil, steam production is also tracked by the boiler plant operators in their daily logs. Figure 4.4.1 graphically reflects the steam production for 1994 by month and boiler. Table 4.4.2 details the steam production of each boiler by month, for 1993 and 1994. Figure 4.4.3 is a graphical comparison of the monthly totals for 1993 and 1994.



1994 Steam Generation
Boiler #1 thru #6
lbs (million)
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
Boiler 1
Boiler 2
Boiler 3
Boiler 5
Boiler 6


Figure 4.4.1

## 1993/1994 Steam Generation
## Log Data – Boilers #1 thru #6
Table 4.4.2

### 1993 – Steam Generation

| Month | Total # Days | Boiler # 1 (mlbs) | Boiler # 2 (mlbs) | Boiler # 3 (mlbs) | Boiler # 5 (mlbs) | Boiler # 6 (mlbs) | Total (mlbs) |
|---|---|---|---|---|---|---|---|
| Jan | 31 | 2,489 | 2,266 | 57,576 | 195 | 12,014 | 74,540 |
| Feb | 28 | 1,624 | 1,401 | 57,447 | 761 | 14,715 | 75,948 |
| March | 31 | 2,818 | 5,423 | 57,695 | 132 | 9,198 | 75,266 |
| April | 30 | 12,685 | 12,098 | 32,554 | 0 | 6,978 | 64,315 |
| May | 31 | 1,647 | 1,851 | 29,181 | 7,228 | 8,431 | 48,338 |
| June | 30 | 9,725 | 10,321 | 29 | 11,278 | 10,910 | 42,261 |
| July | 31 | 4,117 | 3,937 | 0 | 16,504 | 20,295 | 44,852 |
| Aug | 31 | 11,409 | 11,747 | 0 | 9,371 | 11,113 | 43,639 |
| Sept | 30 | 68 | 571 | 0 | 20,045 | 22,174 | 42,857 |
| Oct | 31 | 14,108 | 13,398 | 21,035 | 4,691 | 5,001 | 58,234 |
| Nov | 30 | 23,324 | 28,462 | 0 | 9,659 | 5,908 | 67,352 |
| Dec | 31 | 16,104 | 14,146 | 40,792 | 7,485 | 775 | 79,301 |
| **Totals** | 365 | 100,117 | 105,618 | 296,309 | 87,348 | 127,511 | 716,903 |
| **Average** | 30 | 8,343 | 8,802 | 24,692 | 7,279 | 10,626 | 59,742 |
| **% of Tot.** | N/A | 14.0% | 14.7% | 41.3% | 12.2% | 17.8% | 100.0% |

### 1994 – Steam Generation

| Month | Total # Days | Boiler # 1 (mlbs) | Boiler # 2 (mlbs) | Boiler # 3 (mlbs) | Boiler # 5 (mlbs) | Boiler # 6 (mlbs) | Total (mlbs) |
|---|---|---|---|---|---|---|---|
| Jan | 31 | 4,195 | 11,185 | 60,402 | 7,920 | 7,766 | 91,468 |
| Feb | 28 | 10,529 | 1,752 | 50,866 | 5,748 | 4,407 | 73,302 |
| March | 31 | 8,274 | 3,428 | 60,869 | 0 | 0 | 72,571 |
| April | 30 | 22,416 | 32,033 | 0 | 3,378 | 2,561 | 60,387 |
| May | 31 | 25,155 | 30,158 | 0 | 0 | 1,575 | 56,888 |
| June | 30 | 17,937 | 2,262 | 0 | 3,527 | 16,364 | 40,090 |
| July | 31 | 10,871 | 12,104 | 0 | 0 | 16,951 | 39,926 |
| Aug | 31 | 10,808 | 24,700 | 0 | 7,289 | 1,656 | 44,452 |
| Sept | 30 | 17,059 | 18,935 | 0 | 8,105 | 0 | 44,099 |
| Oct | 31 | 4,916 | 17,489 | 7,167 | 8,961 | 14,828 | 53,362 |
| Nov | 30 | 614 | 660 | 50,019 | 791 | 467 | 52,550 |
| Dec | 31 | 769 | 4,651 | 47,766 | 4,847 | 4,269 | 62,302 |
| **Totals** | 365 | 133,543 | 159,355 | 277,088 | 50,566 | 70,844 | 691,397 |
| **Average** | 30 | 11,129 | 13,280 | 23,091 | 4,214 | 5,904 | 57,616 |
| **% of Tot.** | N/A | 19.3% | 23.0% | 40.1% | 7.4% | 10.2% | 100.0% |

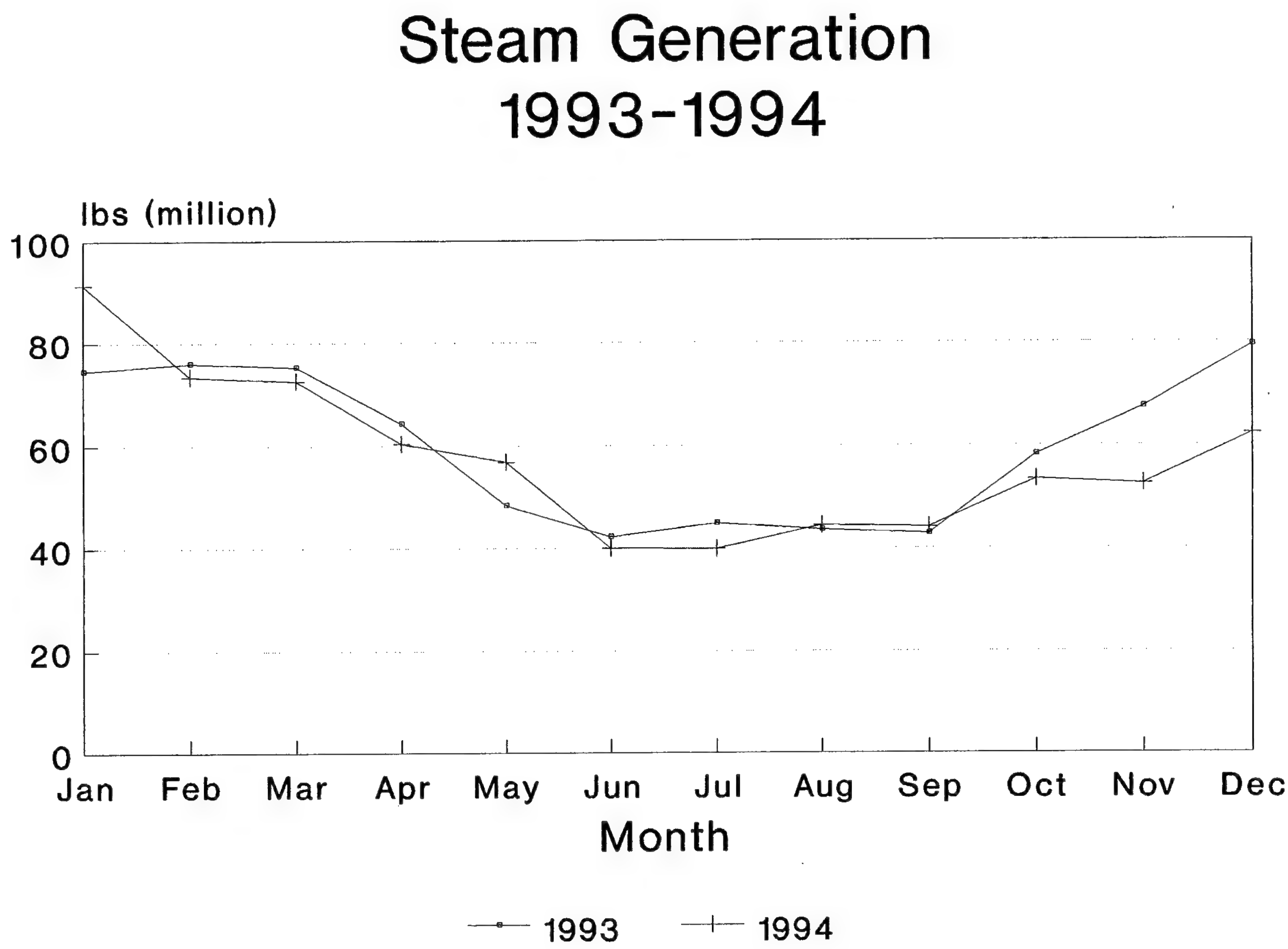

Steam Generation
1993-1994
lbs (million)
100
80
60
40
20
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month
1993
1994

Figure 4.4.3

## 4.5 Electricity

Potomac Edison Company provides power to Fort Detrick. Electricity is supplied at 13,200 volts to Fort Detricks three (3) perimeter substations and then is distributed to the entire site. The site's monthly billing and service contract can be referenced in Attachment 8.2.

Table 4.5.1 displays the electric billing history for 1993 and 1994. All data has been extracted from the actual electric bills, which can be referenced in Attachment 8.2. Supplemental information and meter readings pertaining to the boiler plant are also provided. Table 4.5.2 includes this data in addition to estimated demands and costs. The boiler plant personnel record the monthly usage for the plant itself from a dedicated meter. The boiler plant demand estimates are a direct result of the Electric Model, discussed later in the report.

**THE POTOMAC EDISON COMPANY**
**SITE ELECTRIC USAGE & COSTS**
**JANUARY 1993–DECEMBER 1994**
**ACCOUNT #212160000720017**
**Table 4.5.1**

***JANUARY 1993–DECEMBER 1993 (SITE ELECTRIC BILLING)***

| Month | # of Days | Demand kW (Actual) | Demand kW (Billed) | Demand kW (Difference) | Usage Total kWh | Cost $ | Cost $/kWh | Energy mmBtu | Cost $/mmBtu | kWh Per Day |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 33 | 15,826 | 17,766 | 1,940 | 9,576,000 | $334,572 | $0.035 | 32,683 | $10.24 | 290,182 |
| February | 30 | 15,538 | 17,766 | 2,228 | 8,904,000 | $321,126 | $0.036 | 30,389 | $10.57 | 296,800 |
| March | 29 | 15,221 | 17,766 | 2,545 | 8,496,000 | $322,580 | $0.036 | 30,389 | $10.57 | 307,034 |
| April | 32 | 18,216 | 18,216 | 0 | 10,344,000 | $365,050 | $0.038 | 28,997 | $11.12 | 265,500 |
| May | 29 | 21,240 | 21,240 | 0 | 10,608,000 | $396,087 | $0.035 | 35,304 | $10.34 | 356,690 |
| June | 30 | 23,429 | 23,429 | 0 | 11,904,000 | $441,067 | $0.037 | 36,205 | $10.94 | 353,600 |
| July | 32 | 25,214 | 25,214 | 0 | 14,664,000 | $513,329 | $0.037 | 40,628 | $10.86 | 372,000 |
| August | 29 | 23,890 | 23,890 | 0 | 12,864,000 | $465,720 | $0.035 | 50,048 | $10.26 | 505,655 |
| September | 30 | 24,725 | 24,725 | 0 | 12,792,000 | $469,922 | $0.036 | 43,905 | $10.61 | 428,800 |
| October | 31 | 18,893 | 18,893 | 0 | 10,392,000 | $379,219 | $0.037 | 43,659 | $10.76 | 412,645 |
| November | 30 | 18,763 | 18,911 | 148 | 9,432,000 | $358,965 | $0.036 | 35,468 | $10.69 | 346,400 |
| December | 33 | 15,595 | 18,911 | 3,316 | 9,768,000 | $365,970 | $0.037 | 33,338 | $10.98 | 296,000 |
| AVERAGE | 31 | 19,713 | 20,561 | 848 | 10,812,000 | $394,467 | $0.036 | 36,751 | $10.73 | 352,565 |
| TOTALS | 368 | 236,550 | 246,727 | 10,177 | 129,744,000 | $4,733,609 | N/A | 442,816 | N/A | N/A |

***JANUARY 1994–DECEMBER 1994 (SITE ELECTRIC BILLING)***

| Month | # of Days | Demand kW (Actual) | Demand kW (Billed) | Demand kW (Difference) | Usage Total kWh | Cost $ | Cost $/kWh | Energy mmBtu | Cost $/mmBtu | kWh Per Day |
|---|---|---|---|---|---|---|---|---|---|---|
| January | 30 | 15,451 | 18,911 | 3,460 | 9,072,000 | $358,329 | $0.039 | 30,963 | 11.57 | 302,400 |
| February | 30 | 15,638 | 18,911 | 3,273 | 9,144,000 | $367,369 | $0.040 | 31,208 | 11.77 | 304,800 |
| March | 31 | 17,856 | 18,911 | 1,055 | 9,312,000 | $371,148 | $0.040 | 31,208 | 11.77 | 294,968 |
| April | 30 | 20,534 | 20,534 | 0 | 10,080,000 | $402,775 | $0.040 | 31,782 | 11.68 | 310,400 |
| May | 29 | 20,966 | 20,966 | 0 | 10,296,000 | $426,620 | $0.040 | 34,403 | 11.71 | 347,586 |
| June | 32 | 24,854 | 24,854 | 0 | 13,536,000 | $543,381 | $0.041 | 35,140 | 12.14 | 321,750 |
| July | 30 | 25,070 | 25,070 | 0 | 14,088,000 | $558,949 | $0.040 | 46,198 | 11.76 | 451,200 |
| August | 29 | 23,818 | 23,818 | 0 | 12,840,000 | $518,122 | $0.040 | 48,082 | 11.62 | 485,793 |
| September | 32 | 23,040 | 23,040 | 0 | 12,984,000 | $513,807 | $0.040 | 43,823 | 11.82 | 401,250 |
| October | 29 | 21,614 | 21,614 | 0 | 10,224,000 | $435,637 | $0.040 | 44,314 | 11.59 | 447,724 |
| November | 31 | 19,310 | 19,310 | 0 | 10,080,000 | $423,266 | $0.043 | 34,895 | 12.48 | 329,806 |
| December | 32 | 16,819 | 18,803 | 1,984 | 9,600,000 | $406,809 | $0.042 | 32,765 | 12.42 | 300,000 |
| AVERAGE | 30 | 20,414 | 21,229 | 814 | 10,938,000 | $443,851 | $0.041 | 37,065 | $11.97 | 359,605 |
| TOTALS | 365 | 244,970 | 254,742 | 9,772 | 131,256,000 | $5,326,210 | N/A | 447,977 | N/A | N/A |

**BOILER PLANT – BLDG. 190 ELECTRIC USAGE**
**JANUARY 1993 – DECEMBER 1994**
**TABLE 4.5.2**

***JANUARY 1993 – DECEMBER 1993 (EST. BLDG. 190 ELECTRIC BILLING)***

| Month | # of Days | Demand kW (Estimated) | Metered Usage kWh | Est. Cost $ | Cost $/kWh | Energy mmBtu | Est. Cost $/mmBtu | kWh Per Day |
|---|---|---|---|---|---|---|---|---|
| January | 33 | 253 | 130,400 | $5,399 | $0.041 | 445 | $12.13 | 3,952 |
| February | 30 | 253 | 144,000 | $5,725 | $0.040 | 491 | $11.65 | 4,800 |
| March | 29 | 253 | 136,000 | $5,533 | $0.041 | 491 | $11.65 | 4,966 |
| April | 32 | 203 | 137,600 | $5,123 | $0.037 | 464 | $11.92 | 4,250 |
| May | 29 | 203 | 129,600 | $4,931 | $0.038 | 470 | $10.91 | 4,745 |
| June | 30 | 148 | 93,600 | $3,574 | $0.038 | 442 | $11.15 | 4,320 |
| July | 32 | 148 | 84,000 | $3,343 | $0.040 | 319 | $11.19 | 2,925 |
| August | 29 | 148 | 85,600 | $3,382 | $0.040 | 287 | $11.66 | 2,897 |
| September | 30 | 148 | 86,400 | $3,401 | $0.039 | 292 | $11.58 | 2,853 |
| October | 31 | 203 | 86,400 | $3,894 | $0.045 | 295 | $11.53 | 2,787 |
| November | 30 | 203 | 122,400 | $4,758 | $0.039 | 295 | $13.21 | 2,880 |
| December | 33 | 253 | 128,000 | $5,341 | $0.042 | 437 | $12.23 | 3,879 |
| AVERAGE | 30.67 | 201 | 113,667 | $4,534 | $0.040 | 394 | $11.50 | 3,707 |
| TOTALS | 368 | 2,416 | 1,364,000 | $54,405 | N/A | 4,655 | N/A | N/A |

Note: 1993 Costs are based on 1994 incremental rates

***JANUARY 1994 – DECEMBER 1994 (EST. BLDG. 190 ELECTRIC BILLING)***

| Month | # of Days | Demand kW (Estimated) | Usage Total kWh | Est. Cost $ | Cost $/kWh | Energy mmBtu | Cost $/mmBtu | kWh Per Day |
|---|---|---|---|---|---|---|---|---|
| January | 30 | 253 | 150,400 | $5,879 | $0.039 | 513 | 11.45 | 5,013 |
| February | 30 | 253 | 138,400 | $5,591 | $0.040 | 472 | 11.84 | 4,613 |
| March | 31 | 253 | 132,000 | $5,437 | $0.041 | 472 | 11.84 | 4,465 |
| April | 30 | 203 | 106,400 | $4,374 | $0.041 | 451 | 12.07 | 4,400 |
| May | 29 | 203 | 111,200 | $4,490 | $0.040 | 363 | 12.05 | 3,669 |
| June | 32 | 148 | 86,400 | $3,401 | $0.039 | 380 | 11.83 | 3,475 |
| July | 30 | 148 | 85,600 | $3,382 | $0.040 | 295 | 11.53 | 2,880 |
| August | 29 | 148 | 100,000 | $3,727 | $0.037 | 292 | 11.58 | 2,952 |
| September | 32 | 148 | 91,200 | $3,516 | $0.039 | 341 | 10.92 | 3,125 |
| October | 29 | 203 | 112,000 | $4,509 | $0.040 | 311 | 11.30 | 3,145 |
| November | 31 | 203 | 107,200 | $4,394 | $0.041 | 382 | 11.79 | 3,613 |
| December | 32 | 253 | 124,800 | $5,264 | $0.042 | 426 | 12.36 | 3,900 |
| AVERAGE | 30.42 | 201 | 112,133 | $4,497 | $0.040 | 392 | $11.48 | 3,687 |
| TOTALS | 365 | 2,416 | 1,345,600 | $53,964 | N/A | 4,593 | N/A | N/A |

### 4.5.1 Incremental Cost

Entech Engineering developed a Lotus spreadsheet computer program to determine the incremental cost for electricity. Using actual billing data, usage and demand are imputed into the program, and the bill is calculated. The computer calculation should match the utility's bill.

To calculate the incremental cost for billing demand, the electric bill is then re-calculated using one less kW of demand. The cost difference between the actual bill and the bill calculated with one less kW is considered to be the incremental cost for demand ($/kW).

The same procedure is performed for usage (kWh). The bill is calculated using one less kWh, with the difference in the two costs being the incremental usage cost ($/kWh). For this facility, the incremental cost for electricity is as follows:

***Rate GP, Incremental Costs***
**Demand $/kW = $8.97**
**On-Peak $/kWh = $0.024**

The incremental costs will be used in calculations of the electric, light, and heat loss models, for Energy Conservation Opportunities (ECOs) related to this report.

The use of incremental rates is reasonably accurate for calculating cost savings due to small changes in demand and usage (±25%) from existing levels. The use of incremental rates is less accurate in calculating cost

savings with larger changes in demand and usage (>25%) and tends to underestimate savings slightly (usually less than 2%). However, for the convenience of calculating the feasibility of various options, the use of incremental rates for demand and usage is either accurate or slightly conservative (savings not overestimated) and is therefore prudent.

Copies of the calculations of the incremental cost, and typical monthly bill are included in the Attachments 8.3.

### 4.5.2 Electric Usage

Electric usage is measured in kilowatt hours (kWh). One kWh is equivalent to the usage of 1,000 watts of electricity for one hour. Figure 4.5.2.1 graphically shows the 1993 and 1994 electric usage profiles of Fort Detrick. The usage profiles for the two year associated with the boiler plant is depicted in Figure 4.5.2.2.

### 4.5.3 Monthly Demand

Electrical demand is the highest rate of electrical energy used during a specified time interval (normally 30 minutes). The measurement of electric demand is expressed as kilowatts (1,000 watts). Electrical demand is not necessarily related to the amount of time the electrical components are in operation. The site monthly demand total shown in Table 4.5.1 are from the actual bills, while the boiler plant monthly demands shown in Table 4.5.2 are estimated, and based on calculations associated with determining the electric use model for boiler plant. Details of this calculation are discussed later in the Energy Models Section.

## Fort Detrick
### Site Electric Usage

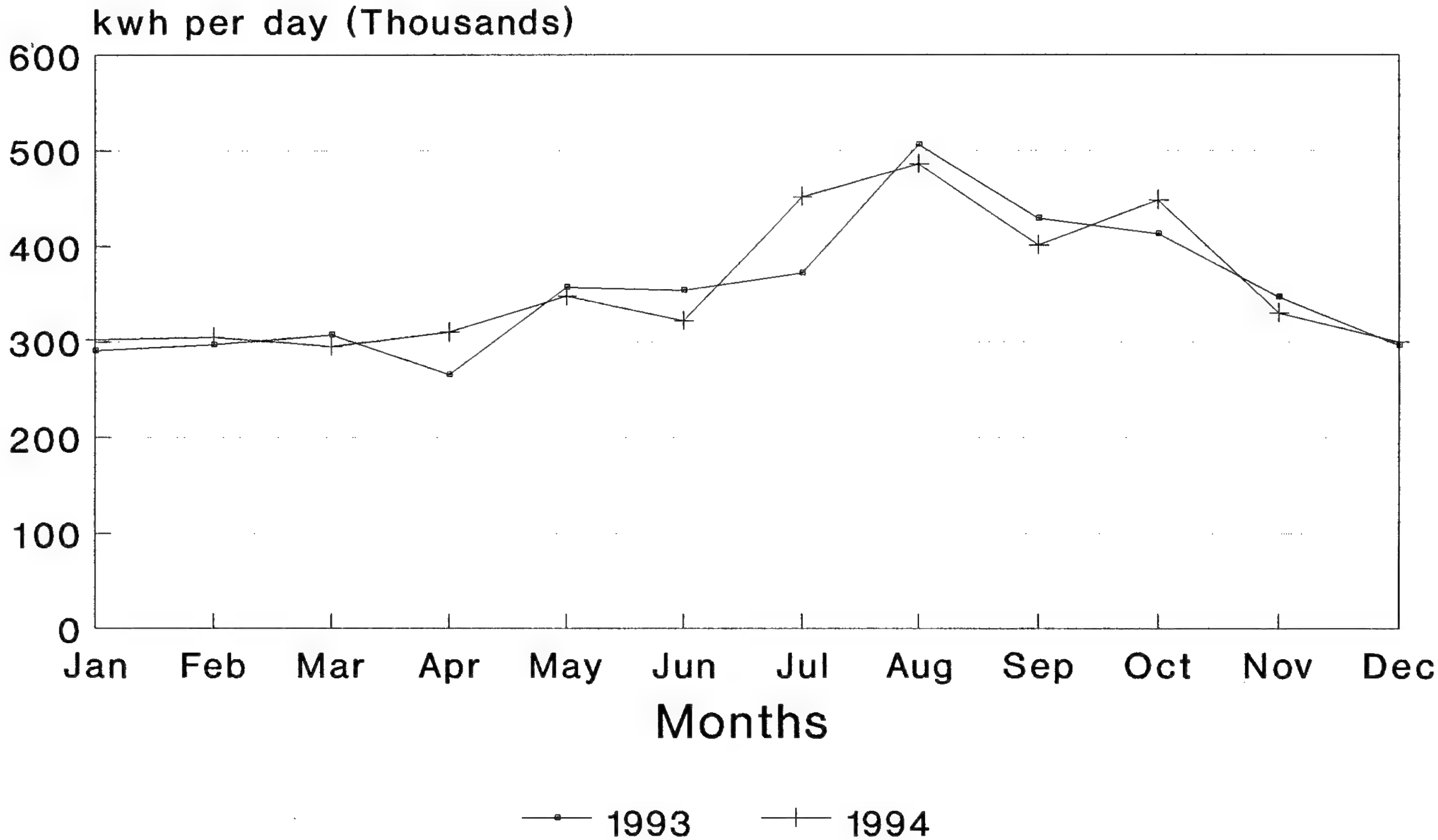
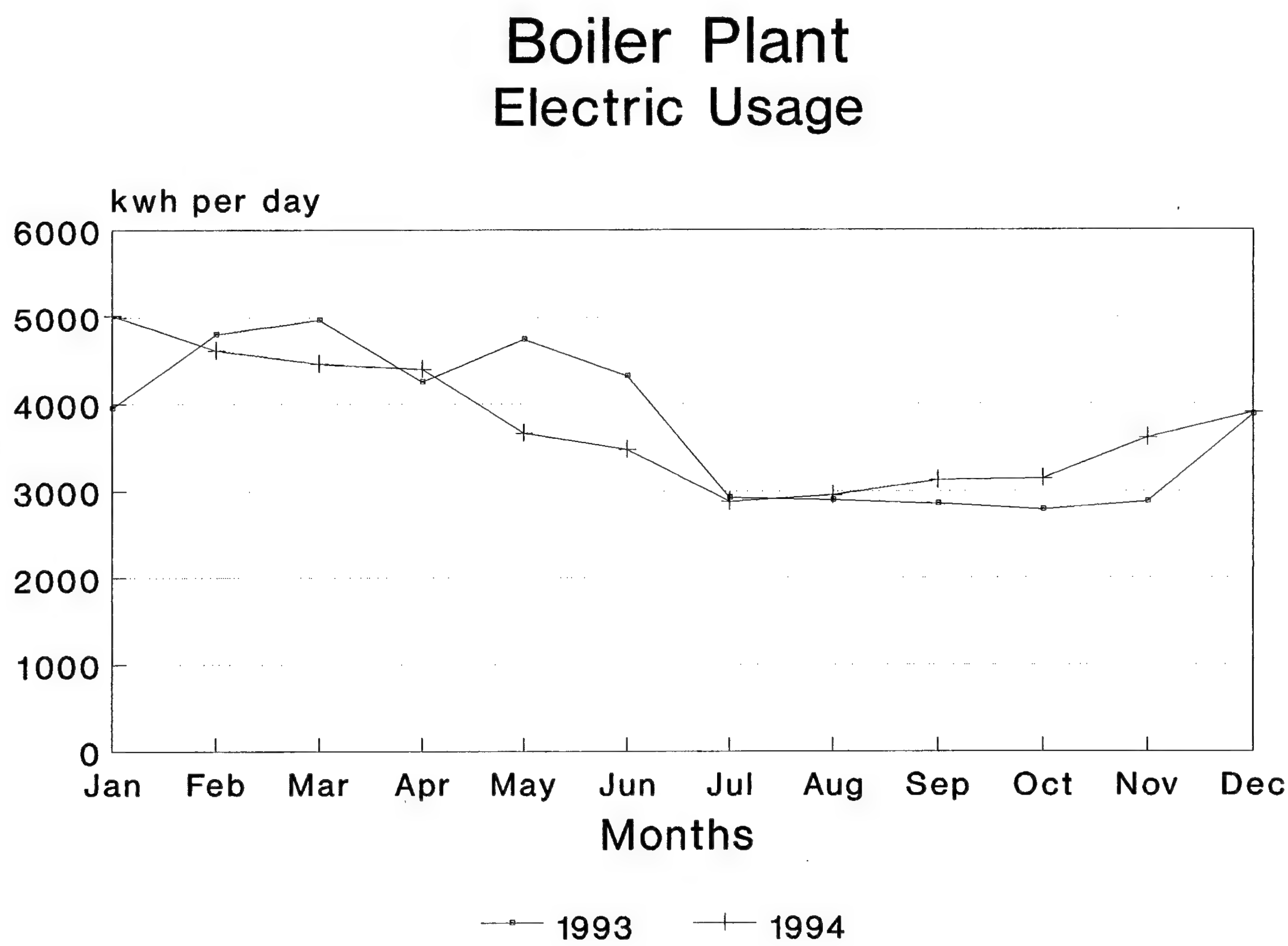



Figure 4.5.2.1



Boiler Plant
Electric Usage
kwh per day
6000
5000
4000
3000
2000
1000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Months
1993
1994


Figure 4.5.2.2

## 4.6 Energy Cost and Usage Summary

### 4.6.1 General

The boiler plant uses a significant amount of natural gas and No. 6 fuel oil to heat their steam. In addition, the plant consumes its fair share of electricity relative to its size. The following section is a summary of the boiler plant's energy costs and usage totals

### 4.6.2 Total Energy Costs and Energy Incremental Costs

The total energy costs and incremental costs associated with operating the boiler plant are as follows in Table 4.6.2.1. Figure 4.6.2.2 is also provided to give a graphical look at the impact of the individual total energy costs.

**Summary of Energy Costs and Incremental Costs for Boiler Plant**
**Table 4.6.2.1**

| Energy Source | Cost | Percent | Incremental Cost |
|---|---|---|---|
| Natural Gas | $2,146,135 | 74% | $3.53/mcf |
| No. 6 Fuel Oil | $691,150 | 24% | $0.42/gal |
| Electricity | $53,964 | 2% | $8.97/kW (Demand) |
| --- | --- | --- | $0.024 kWh (Usage) |
| **Total** | **$2,891,249** | --- | --- |

Note: The gas cost total shown above reflects the costs billed by Frederick Gas to Fort Detrick. Gas costs as listed in the ECOs will differ because the mcf totals used are from the Boiler logs.

## Boiler Plant Energy Cost

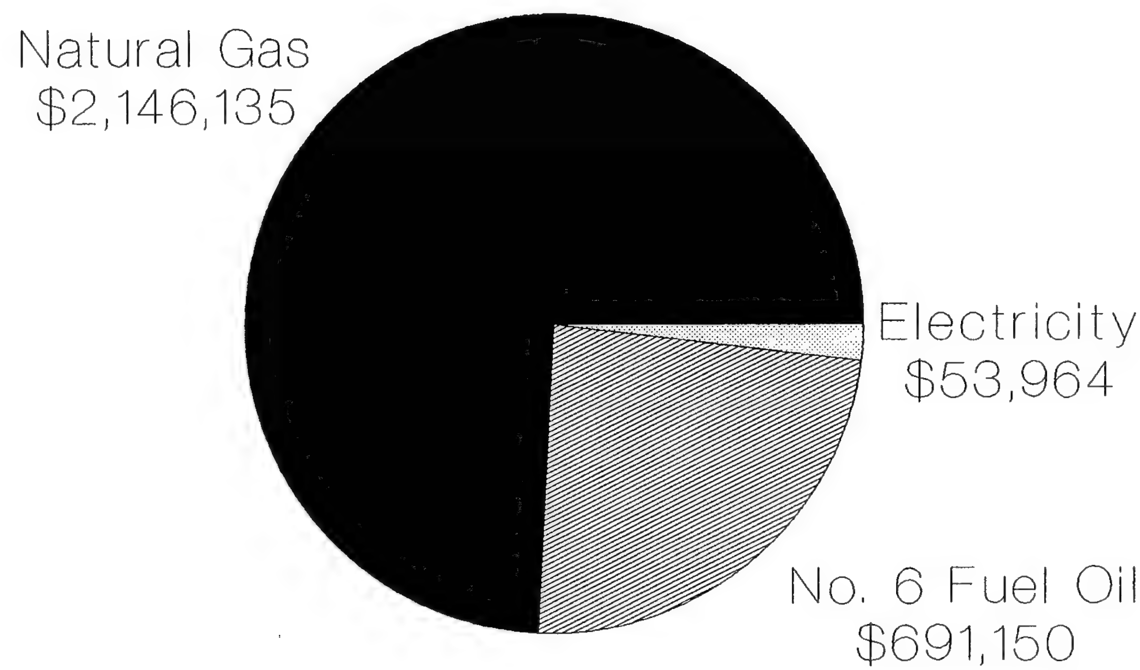



Figure 4.6.2.1

### 4.6.3 Incremental Energy Cost for Steam

Based on the boiler log data and the fuel incremental rates determined previously, the incremental rate for $/mlbs of steam produced is $4.35/mlb.

| | | |
|---|---|---|
| Natural Gas | = | 656,537 mcf/yr |
| No. 6 Fuel Oil | = | 1,645,571 gal/yr |
| Steam Produced | = | 691,597 mlbs/yr |
| Steam Incremental Rate | = | $4.35/mlbs |

$$\frac{656{,}537\,\frac{mcf}{yr} \; x \; \frac{\$3.53}{mcf} + 1{,}645{,}571\,\frac{gal}{yr} \; x \; \frac{\$0.42}{gal}}{691{,}597\;\frac{mlbs}{yr}} = \$4.35/mlbs$$

This cost is for information only and is not used in ECOs because of the special requirements of the Life Cycle Analyses.

### 4.6.4 Total Energy (mmBtu)

The total energy in mmBtu used by the boiler plant is shown in Table 4.6.4.1.

**Total Energy Usage in Boiler Plant**
**Table 4.6.4.1**

| Energy Source | Total Usage (log) | Conversion | mmBtu/yr |
|---|---|---|---|
| Natural Gas (mcf/yr) | 656,537 | 1.03 mmBtu/mcf | 676,233 |
| No. 6 Fuel Oil (gal/yr) | 1,645,571 | 149,690 btu/gal | 246,325 |
| Electricity (kW/yr) | 1,345,600 | 3,413 btu/kW | 4,592 |
| **Total** | | | **927,150** |

## 5.0 ENERGY MODELS

### 5.1 General

Measured data about steam production and energy consumption (gas, oil and electricity) at the boiler plant were presented in the billing history section of this study. In this section of the report Entech examines how the steam produced and energy consumed is utilized. Before evaluating ECOs it is essential to understand the energy consumption patterns and how each type of energy user contributes to the overall boiler plant energy use and cost. As described in the Methodology Section of this report, the steam use model which is a summary of the nine individual models, the fuel use model, the lighting model and the electric model will be employed during this task.

### 5.2 Space Heating

The space heating load for each of the buildings connected to the steam system was estimated based on building information collected during Entech's December site survey, as described in the Methodology Section of this report.

The first step to estimating the space heating loads for each building is to calculate the heat loss through the building shell. Buildings were grouped together based upon building construction. The building space heating load was then estimated on Btuh/sf basis for each construction type. For example, buildings with wood frame construction are estimated to typically have a design space heating load of approximately 65 Btuh/sf of building floor area.

Table 5.2.1 shows the heat loss values used for each building type. The calculations used to derive these heat loss figures can be referenced in Attachment 8.4 of this report.

**Estimated Heat Loss by Building Type**
**Table 5.2.1**

| Code | Building Type | Unit Heat Loss |
|---|---|---|
| PE | Pre-Engineered Building | 35 Btuh/sf |
| UM | Uninsulated Masonry Building | 60 Btuh/sf |
| IM | Insulated Masonry Building | 55 Btuh/sf |
| WF | Wood Frame Construction | 65 Btuh/sf |
| PB | Plywood/Particle Board Const. | 115 Btuh/sf |
| NM | New Masonry Building | 30 Btuh/sf |
| GH | Greenhouse | 165 Btuh/sf |

In addition to heat loss through the skin of the building, space heating due to building ventilation must be estimated. The buildings at Fort Detrick can be generally classified into laboratory, office and warehouse use. Each of these use classifications requires a different quantity of ventilation air (outdoor air) that must be heated to maintain room temperature during the winter months. Published data indicates that laboratories typically have 1.15 cfm/sf of ventilation air. Offices typically have 0.25 cfm/sf and warehouses are not expected to have any mechanical ventilation. The heat required to warm this air to room temperature is calculated as follows:

$$1.08\ \frac{Btuh}{cfm°F}\ x\ \frac{Btu}{sf}\ x\ 60°F = QVENT$$

The resulting heat loss for ventilation for different building uses is shown in Table 5.2.2

**Estimated Ventilation Heat Loss by Building Use**
**Table 5.2.2**

| Code | Building Use | Ventilation Heat Loss |
|---|---|---|
| L | Laboratory | + 75 Btuh/sf |
| O | Office | + 15 Btuh/sf |
| W | Warehouse | + 0 Btuh/sf |

The heat loss through the building shell and ventilation heat loss is combined to estimate the total space heating load for each building. Table 5.2.3 on the following pages lists the building number, name, and use for each building at Fort Detrick that is served by steam. The building type classification and building use classification, as described above, is shown in the table. The calculated space heating load in Btuh/sf is shown for each building.

The estimated peak heating load in Btuh is calculated by multiplying Btuh/sf by the building size. For example, Building S-10 is an uninsulated masonry building that is used as an office. The heat loss for this building is therefore 60 Btuh/sf + 15 Btuh/sf = 75 Btuh/sf. Peak heating load = 75 Btuh/sf x 4,600 sf = 345,000 Btuh, or 350 lb/hr.

# FORT DETRICK
## FREDERICK, MARYLAND
## Table 5.2.3
## HEATING LOAD FOR BUILDINGS USING STEAM

| Bldg. No. | Building Name | Building Use | Building Type | | Building SF | BTUH/SF | Heating BTUH | Steam LB/HR | Steam LB/YR | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| S-10 | Signal Service | Office | UM | O | 4,600 | 75 | 345,000 | 350 | 437,000 | |
| S-11 | Thrift Shop | Store | UM | O | 3,000 | 75 | 225,000 | 230 | 285,000 | |
| S-12 | Signal Service | Empty? | UM | O | 1,000 | 75 | 75,000 | 80 | 95,000 | |
| S-100 | Outside Electric Shop | Warehouse/Shop/Office | PE | W | 5,000 | 35 | 175,000 | 180 | 222,000 | |
| S-101 | Sewage Pump | | PE | W | 800 | 35 | 28,000 | 30 | 35,000 | |
| S-122 | Rodent/Pest Control | Storage | PE | W | 1,100 | 35 | 38,500 | 40 | 49,000 | |
| 190 | BOILER PLANT | | UM | O | 11,200 | 75 | 840,000 | 840 | 1,064,000 | |
| S-199 | FE Mnt. Shop | Wharehouse/Shop | PE | W | 12,100 | 35 | 423,500 | 420 | 536,000 | |
| 200 | | Equipment Shed | PE | W | 1,200 | 35 | 42,000 | 40 | 53,000 | |
| S-201 | Engineering Offices | Offices | PE | O | 25,300 | 50 | 1,265,000 | 1,270 | 1,602,000 | |
| T-239 | Cancer Research Center | Warehouse | UM | W | 10,000 | 60 | 600,000 | 600 | 760,000 | |
| S-243 | Fe Sths | Warehouse/Shop | UM | W | 6,600 | 60 | 396,000 | 400 | 501,000 | |
| S-244 | Cancer Research Center | Office | UM | O | 5,100 | 75 | 382,500 | 380 | 484,000 | |
| T-248 | Cancer Research Center | Warehouse | PB | W | 4,800 | 115 | 552,000 | 550 | 699,000 | |
| T-249 | Cancer Research Center | Warehouse | PB | W | 4,800 | 115 | 552,000 | 550 | 699,000 | |
| S-261 | Radiology | Labratory | UM | L | 2,500 | 135 | 337,500 | 340 | 427,000 | |
| S-262 | Gen. Storehouse | Warehouse | PE | W | 5,000 | 35 | 175,000 | 180 | 222,000 | |
| S-263 | Fe Mnt Shop | Mech Shops/Storehouse | UM | W | 13,900 | 60 | 834,000 | 830 | 1,056,000 | |
| S-312 | CRC - Fermentation Production Facility | | UM | W | 400 | 60 | 24,000 | 20 | 30,000 | Fenced in with 313 |
| S-313 | CRC - Fermentation Production Facility | | UM | L | 2,300 | 135 | 310,500 | 310 | 393,000 | |
| 314 | Cancer Research Center | Warehouse/Shop | PE | W | 3,800 | 35 | 133,000 | 130 | 168,000 | |
| S-318 | | Warehouse | UM | W | 3,300 | 60 | 198,000 | 200 | 251,000 | |
| S-319 | | Warehouse | UM | W | 3,300 | 60 | 198,000 | 200 | 251,000 | |
| S-321 | Cancer Research Center | Office | UM | O | 4,000 | 75 | 300,000 | 300 | 380,000 | Currently under construction |
| S-322 | Cancer Research Center | Office | UM | O | 4,000 | 75 | 300,000 | 300 | 380,000 | |
| S-323 | Cancer Research Center | Warehouse | PE | W | 3,300 | 35 | 115,500 | 120 | 146,000 | |
| S-324 | NCI-FCRF Central Supply & Trans | Warehouse | PE | W | 7,500 | 35 | 262,500 | 260 | 332,000 | |
| S-325 | Cancer Research Center | Labratory | IM | L | 12,800 | 130 | 1,664,000 | 1,660 | 2,107,000 | |
| 326 | USDA | Storage | UM | W | 200 | 60 | 12,000 | 10 | 15,000 | |
| S-347 | Cancer Research Center | Chemical Storage | UM | W | 2,000 | 60 | 120,000 | 120 | 152,000 | |
| 349 | Cancer Research Center | Office | WF | O | 3,000 | 80 | 240,000 | 240 | 304,000 | |
| S-350 | Cancer Research Center | Office/Maintenance | UM | O | 9,300 | 75 | 697,500 | 700 | 883,000 | |
| S-361 | Cancer Research Center | Maintenance Shop | UM | W | 11,400 | 60 | 684,000 | 680 | 866,000 | |
| T-362 | Cancer Research Center | Office | WF | O | 9,400 | 80 | 752,000 | 750 | 952,000 | |
| 374 | USDA | Lab | UM | L | 18,400 | 135 | 2,484,000 | 2,480 | 3,146,000 | |
| 375 | Steam Sterilization Plant | Shop | UM | O | 21,200 | 75 | 1,590,000 | 1,590 | 2,014,000 | |
| 376 | Cancer Research Center | Labratory | NM | L | 31,300 | 105 | 3,286,500 | 3,290 | 4,162,000 | |
| 393 | Incinerator | Incinerator | UM | L | 7,600 | 135 | 1,026,000 | 1,030 | 1,299,000 | |
| S-426 | CRC-Safety Protective Services | Offices/Med | IM | O | 6,800 | 70 | 476,000 | 480 | 603,000 | |
| 427 | Cancer Research Center | Office | IM | O | 6,000 | 70 | 420,000 | 420 | 532,000 | |
| 428 | Cancer Research Center | Office | IM | O | 7,400 | 70 | 518,000 | 520 | 656,000 | |

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.2.3**
**HEATING LOAD FOR BUILDINGS USING STEAM**

| Bldg. No. | Building Name | Building Use | Building Type | | Building SF | BTUH/SF | Heating BTUH | Steam LB/HR | Steam LB/YR | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 429 | Cancer Research Center | Lab | WF | L | 6,400 | 140 | 896,000 | 900 | 1,135,000 | |
| 430 | Cancer Research Center | Office | NM | O | 6,000 | 45 | 270,000 | 270 | 342,000 | |
| 431 | Cancer Research Center | Lab | UM | L | 12,000 | 135 | 1,620,000 | 1,620 | 2,052,000 | |
| S-432 | Cancer Research Center | Lab | NM | L | 21,500 | 105 | 2,257,500 | 2,260 | 2,859,000 | |
| S-433 | Cancer Research Center | Lab | WF | L | 5,800 | 140 | 812,000 | 810 | 1,028,000 | Replaced with a new lab |
| S-434 | CRC - Fermentation | Offices/Lab | WF | O | 13,800 | 80 | 1,104,000 | 1,100 | 1,398,000 | |
| S-459 | Cancer Research Center | Warehouse/Shop | UM | O | 10,200 | 75 | 765,000 | 770 | 969,000 | Undergoing major renov. |
| 469 | Cancer Research Center | Labratory | UM | L | 56,100 | 135 | 7,573,500 | 7,570 | 9,591,000 | |
| 472 | Cancer Research Center | Labratory | UM | L | 6,500 | 135 | 877,500 | 880 | 1,111,000 | Contains numerous tanks. |
| T-501 | Education/Library | Office | WF | O | 7,600 | 80 | 608,000 | 610 | 770,000 | |
| S-504 | USAMRDC | Office | WF | O | 9,800 | 80 | 784,000 | 780 | 993,000 | |
| S-505 | HQ USAMRDC | Office | WF | O | 3,900 | 80 | 312,000 | 310 | 395,000 | |
| S-521 | Adm Gen Purp | Office | WF | O | 11,500 | 80 | 920,000 | 920 | 1,165,000 | |
| S-522 | Cancer Research Center | Labratory | WF | L | 13,000 | 140 | 1,820,000 | 1,820 | 2,305,000 | |
| S-524 | USAMBRDL Admin | Office | UM | L | 5,300 | 135 | 715,500 | 720 | 906,000 | |
| S-525 | Adm Gen Purp | Office | WF | O | 6,500 | 80 | 520,000 | 520 | 659,000 | |
| 538 | Cancer Research Center | Labratory | UM | L | 64,200 | 135 | 8,667,000 | 8,670 | 10,976,000 | |
| 539 | CRC-Leroy D. Fothergill Lab | Lab | IM | L | 110,400 | 130 | 14,352,000 | 14,350 | 18,175,000 | |
| 549 | Cancer Research Center | Library | IM | O | 15,000 | 70 | 1,050,000 | 1,050 | 1,330,000 | |
| 550 | Cancer Research Center | Labratory | UM | L | 20,000 | 135 | 2,700,000 | 2,700 | 3,419,000 | |
| 560 | Cancer Research Center | Labratory | NM | L | 170,000 | 105 | 17,850,000 | 17,850 | 22,605,000 | |
| 562 | Cancer Research Center | Labratory | NM | L | 15,000 | 105 | 1,575,000 | 1,580 | 1,995,000 | |
| 567 | Cancer Research Center | Lab | NM | L | 33,000 | 105 | 3,465,000 | 3,470 | 4,388,000 | |
| 568 | Biomedical R&D lab | Lab | NM | L | 49,300 | 105 | 5,176,500 | 5,180 | 6,556,000 | |
| 571 | CRC-ANIMAL BUILDINGS | Labratory | NM | L | 35,700 | 105 | 3,748,500 | 3,750 | 4,747,000 | |
| 576 | CRC-Biological Response Modifiers | Office | NM | O | 2,200 | 45 | 99,000 | 100 | 125,000 | |
| T-611 | William Strough Auditorium | Auditorium w/stage | UM | L | 5,200 | 135 | 702,000 | 700 | 889,000 | |
| S-660 | Visiting Officers Quarters | Residence | UM | O | 12,200 | 75 | 915,000 | 920 | 1,159,000 | |
| T-701 | | Office | WF | O | 2,000 | 80 | 160,000 | 160 | 203,000 | |
| T-703 | Fire Station | | WF | O | 2,300 | 80 | 184,000 | 180 | 233,000 | |
| T-713 | Post Exchange | Post Exchange | WF | O | 9,600 | 80 | 768,000 | 770 | 973,000 | |
| T-715 | Judge Advocate/Legal Assist DVQ R | Office | WF | O | 2,400 | 80 | 192,000 | 190 | 243,000 | |
| T-718 | Community Club | Community Club | UM | O | 10,500 | 75 | 787,500 | 790 | 997,000 | |
| T-722 | Adm. Gen Purp. | Office | WF | O | 9,600 | 80 | 768,000 | 770 | 973,000 | |
| T-817 | ASAMRAA | Office | WF | O | 10,400 | 80 | 832,000 | 830 | 1,054,000 | |
| 810 | Administration | Office | NM | O | 34,200 | 45 | 1,539,000 | 1,540 | 1,949,000 | |
| T-818 | Administration | | WF | O | 2,000 | 80 | 160,000 | 160 | 203,000 | Connected to 817 |
| T-819 | ASAMRAA | Office | WF | O | 1,400 | 80 | 112,000 | 110 | 142,000 | |
| T-820 | ASAMRAA | Office | WF | O | 7,200 | 80 | 576,000 | 580 | 729,000 | Connnected to 817 |
| T-823 | Medical Logistics | Office | WF | O | 2,100 | 80 | 168,000 | 170 | 213,000 | |
| T-824 | Medical Logistics | Office | WF | O | 2,100 | 80 | 168,000 | 170 | 213,000 | |

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.2.3**
**HEATING LOAD FOR BUILDINGS USING STEAM**

| Bldg. No. | Building Name | Building Use | Building Type | | Building SF | BTUH/SF | Heating BTUH | Steam LB/HR | Steam LB/YR | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| T-830 | Training Center | Office | PB | O | 7,500 | 130 | 975,000 | 980 | 1,235,000 | |
| T-833 | Navy | Office | PB | O | 6,700 | 130 | 871,000 | 870 | 1,103,000 | |
| T-834 | Navy | Office | PB | O | 500 | 130 | 65,000 | 70 | 82,000 | Connected to 833 |
| T-835 | | Office | PB | O | 1,600 | 130 | 208,000 | 210 | 263,000 | |
| T-838 | Field House | Field House/Gym | PB | L | 13,400 | 190 | 2,546,000 | 2,550 | 3,224,000 | |
| S-839 | Fitness Center | Gym | PE | L | 5,000 | 110 | 550,000 | 550 | 697,000 | |
| T-901 | Gen. Store House | Warehouse | PB | W | 10,000 | 115 | 1,150,000 | 1,150 | 1,456,000 | |
| T-902 | Motor Pool | Office | WF | O | 4,600 | 80 | 368,000 | 370 | 466,000 | |
| T-903 | Motor Pool | Office | WF | O | 2,000 | 80 | 160,000 | 160 | 203,000 | |
| T-904 | Motor Pool | Office | WF | O | 2,000 | 80 | 160,000 | 160 | 203,000 | |
| T-914 | PM Adm | Office | WF | O | 3,700 | 80 | 296,000 | 300 | 375,000 | |
| 915 | Bowling Center | Bowling/Office | PB | O | 5,000 | 130 | 650,000 | 650 | 823,000 | |
| T-921 | Car Wash/Auto Shop | Shop | PB | W | 3,400 | 115 | 391,000 | 390 | 495,000 | |
| T-925 | Religious Education | Training/Education | WF | O | 2,100 | 80 | 168,000 | 170 | 213,000 | |
| 949 | YOUTH CENTER | Youth Center | NM | O | 5,200 | 45 | 234,000 | 230 | 296,000 | |
| 1021 | Cancer Research Center | Admin/Food Storage | UM | O | 7,500 | 75 | 562,500 | 560 | 712,000 | |
| 1022-1049 | CRC-ANIMAL BUILDINGS | Animal Storage | IM | L | 36,000 | 130 | 4,680,000 | 4,680 | 5,927,000 | |
| 1040 | CRC-ANIMAL BUILDINGS | Maintenance | UM | W | 3,000 | 60 | 180,000 | 180 | 228,000 | |
| 1050 | Cancer Research Center | Warehouse/Offices | PE | W | 40,000 | 35 | 1,400,000 | 1,400 | 1,773,000 | |
| 1054 | Medical Advance Tech Mgmnt | Office/Warehouse | IM | O | 37,000 | 70 | 2,590,000 | 2,590 | 3,280,000 | |
| 1301 | USDA | Labs/Offices | IM | L | 39,900 | 130 | 5,187,000 | 5,190 | 6,569,000 | |
| 1302 | USDA | Labs/Offices | IM | L | 8,800 | 130 | 1,144,000 | 1,140 | 1,449,000 | Attached to 1301 |
| 1303 | USDA | Greenhouse | GH | W | 3,700 | 165 | 610,500 | 610 | 773,000 | |
| 1304 | USDA | Greenhouse | GH | W | 3,700 | 165 | 610,500 | 610 | 773,000 | |
| 1305 | USDA | Greenhouse | GH | W | 3,700 | 165 | 610,500 | 610 | 773,000 | |
| 1306 | USDA | Greenhouse | GH | W | 3,700 | 165 | 610,500 | 610 | 773,000 | |
| 1412 | USAMRIID ANNEX | Lab | NM | L | 70,000 | 105 | 7,350,000 | 7,350 | 9,308,000 | |
| 1414 | USAMRIID ANNEX | Warehouse | UM | W | 2,000 | 60 | 120,000 | 120 | 152,000 | |
| 1422 | DATA PROCESSING | Office | NM | O | 11,200 | 45 | 504,000 | 500 | 638,000 | |
| 1425 | USAMRIID ANNEX | Lab | NM | L | 224,100 | 105 | 23,530,500 | 23,530 | 29,799,000 | |
| 1430 | ENLISTED BARRACKS | Residence | IM | O | 38,200 | 70 | 2,674,000 | 2,670 | 3,386,000 | |
| 1520 | Commisary | Commisary | UM | O | 40,100 | 75 | 3,007,500 | 3,010 | 3,809,000 | |
| | | | | | 1,766,200 | | 175,883,000 | 175,880 | 222,739,000 | |

1. Heating Degree Days based on data collected at the Fort Detrick Boiler Plant.

After the peak heating load is estimated, the annual steam consumption can be calculated using the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) heating degree day formula. The heating degree day (HDD) formula is as follows:

$$Annual\ Energy = \left( \frac{Peak\ heat\ loss\ x\ HDD\ x\ 24\ \frac{Hrs}{day}}{temp\ diff.\ x\ Btu/unit\ fuel} \right) x\ C_D$$

Again using building S-10 as an example, the annual expected steam use by this building is 437,000 lb/yr.

$$Annual\ Energy = \left( \frac{345{,}000\ Btuh\ x\ 5{,}532\ HDD\ x\ 24\ \frac{hrs}{day}}{65\ °F\ x\ 1{,}000\ Btu/lb} \right) x\ 0.62 = 437{,}000\ \frac{lb}{yr}$$

Fort Detrick measured 5,532 heating degree days during the winter of 1994 at the boiler plant. This degree day information has a very good correlation with the steam production profile. The measured data was therefore considered preferable to published degree day information. $C_D$ is an empirical correction factor described in the ASHRAE Fundamentals Handbook. As described in the Methodology Section, steam is assumed to have an energy value of 1,003 btu/lb, and temperature difference is the difference in indoor and outdoor temperatures on a "design" day.

The space heating model, Table 5.2.3, shows that the total steam usage for space heating at Fort Detrick has been calculated to be 223 million pounds per year. Table 5.2.4 summarizes the heat loss model results by type of building.

## Space Heating Model Results
## Table 5.2.4

| Building Type | Building Square Feet | % of Building Square Feet | Total Annual Steam (lb/yr) | Space Heating Steam % Total |
|---|---|---|---|---|
| Pre-Engineered | 110,100 | 6.2% | 5,835,000 | 2.6% |
| Uninsulated Masonry | 400,400 | 22.7% | 52,207,000 | 23.4% |
| Insulated Masonry | 318,300 | 18.1% | 44,014,000 | 19.8% |
| Wood Frame | 156,200 | 8.8% | 17,743,000 | 8.0% |
| Particle Board/Plywood | 57,700 | 3.3% | 10,079,000 | 4.5% |
| New Masonry | 708,700 | 40.1% | 89,769,000 | 40.3% |
| Greenhouse | 14,800 | 0.8% | 3,092,000 | 1.4% |
| **Total** | **1,766,200** | **100%** | **222,739,000** | **100%** |

Most of the heating load occurs in the masonry buildings. These buildings comprise 80.8% of the square footage of the buildings heated by steam. The masonry buildings typically house the laboratories, which have high ventilation loads as well. Figure 5.2.5 on the following page graphically displays the space heating model results.

# Space Heating Model Results
## Building Type

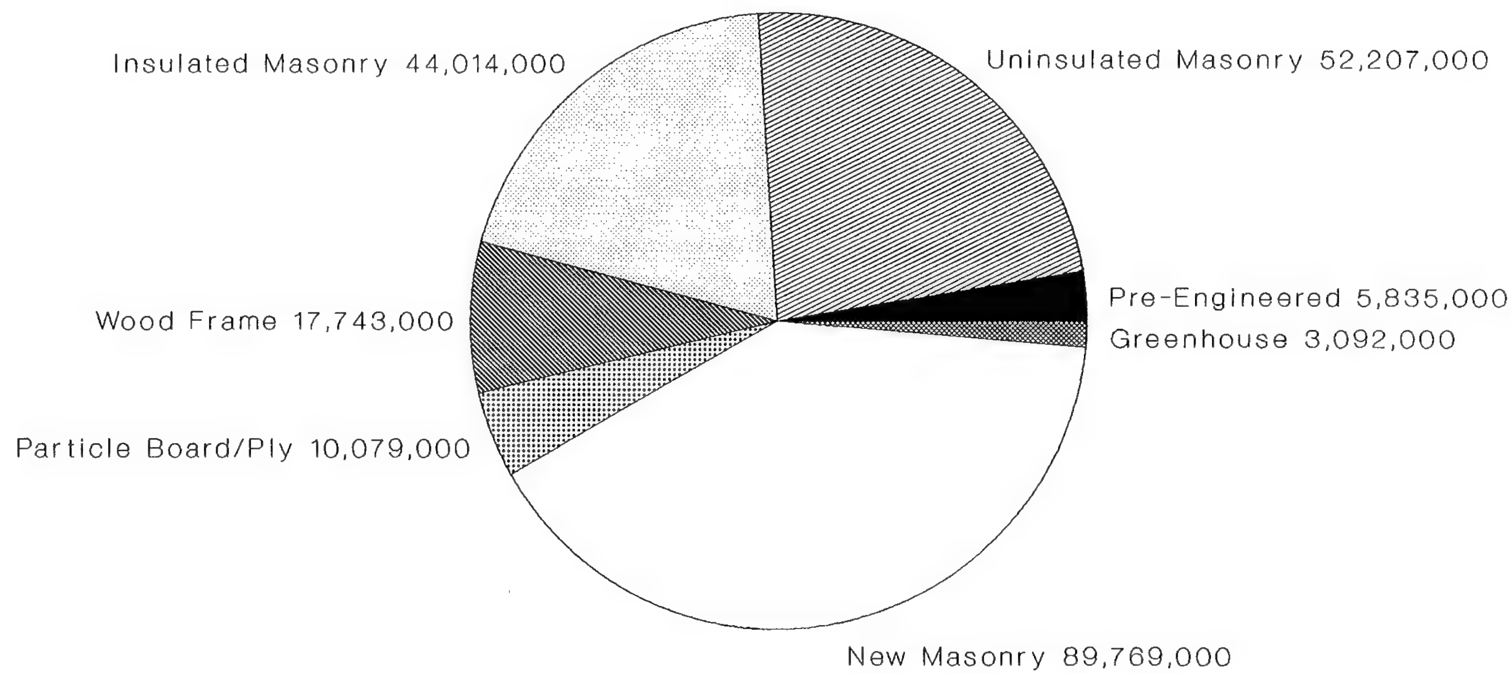



**Figure 5.2.5**

## 5.3 Reheats

During the winter, outside air brought into a building for ventilation must be heated before being introduced to the occupied space. Steam used to heat the outside air in the winter is included in the space heating model. In the summer time, warm humid air is brought into the building for ventilation. This air must be cooled to 50-55°F to remove the excess moisture in the air. The air is then reheated to space temperature before being introduced to the space.

BIG ASSUMPTION

Steam is assumed to be used for reheats during April, through September, and for half of October and November. All animal buildings and animal labs, and laboratories with more than 10,000 square feet are assumed to have reheats. Table 5.3.1, the Reheat Model, indicates which buildings use steam for reheating air.

The amount of steam required for reheats is based on the amount of ventilation air. The formulas shown below describe calculation of peak and annual steam use for reheats. Calculation results are tabulated in Table 5.3.1.

$$Peak = \left( \frac{sf \ x \ 1.15 \ \frac{cfm}{sf} \ x \ 1.08 \ \frac{Btuh}{cfm°F} \ x \ 20°F}{1{,}000 \ \frac{Btu}{lb}} \right)$$

$$Annual = \left( \frac{sf \ x \ 1.15 \ \frac{cfm}{sf} \ x \ 1.08 \ \frac{Btuh}{cfm°F} \ x \ 20°F}{1{,}000 \ \frac{Btu}{lb}} \right) \ x \ 24 \ \frac{hrs}{day} \ x \ 30 \ \frac{day}{mo} \ x \ 7 \ full \ months$$

The total steam use for reheats is estimated to be 131 million pounds per year.

## FORT DETRICK
### FREDERICK, MARYLAND
### Table 5.3.1
### ESTIMATE OF TOTAL STEAM USE FOR REHEATS

| Bldg. No. | Building Name | Building Use | Building Type | Building SF | Reheat | Peak Lb/Hr | Annual Lb/Yr |
|---|---|---|---|---|---|---|---|
| S-10 | Signal Service | Office | O | 4,600 | No | 0 | 0 |
| S-11 | Thrift Shop | Store | O | 3,000 | No | 0 | 0 |
| S-12 | Signal Service | Empty? | O | 1,000 | No | 0 | 0 |
| S-100 | Outside Electric Shop | Warehouse/Shop/Office | W | 5,000 | No | 0 | 0 |
| S-101 | Sewage Pump | | W | 800 | No | 0 | 0 |
| S-122 | Rodent/Pest Control | Storage | W | 1,100 | No | 0 | 0 |
| 190 | BOILER PLANT | | O | 11,200 | No | 0 | 0 |
| S-199 | FE Mnt. Shop | Wharehouse/Shop | W | 12,100 | No | 0 | 0 |
| 200 | | Equipment Shed | W | 1,200 | No | 0 | 0 |
| S-201 | Engineering Offices | Offices | O | 25,300 | No | 0 | 0 |
| T-239 | Cancer Research Center | Warehouse | W | 10,000 | No | 0 | 0 |
| S-243 | Fe Sths | Warehouse/Shop | W | 6,600 | No | 0 | 0 |
| S-244 | Cancer Research Center | Office | O | 5,100 | No | 0 | 0 |
| T-248 | Cancer Research Center | Warehouse | W | 4,800 | No | 0 | 0 |
| T-249 | Cancer Research Center | Warehouse | W | 4,800 | No | 0 | 0 |
| S-261 | Radiology | Labratory | L | 2,500 | No | 0 | 0 |
| S-262 | Gen. Storehouse | Warehouse | W | 5,000 | No | 0 | 0 |
| S-263 | Fe Mnt Shop | Mech Shops/Storehouse | W | 13,900 | No | 0 | 0 |
| S-312 | CRC - Fermentation Production Facility | | W | 400 | No | 0 | 0 |
| S-313 | CRC - Fermentation Production Facility | | L | 2,300 | No | 0 | 0 |
| 314 | Cancer Research Center | Warehouse/Shop | W | 3,800 | No | 0 | 0 |
| S-318 | | Warehouse | W | 3,300 | No | 0 | 0 |
| S-319 | | Warehouse | W | 3,300 | No | 0 | 0 |
| S-321 | Cancer Research Center | Office | O | 4,000 | No | 0 | 0 |
| S-322 | Cancer Research Center | Office | O | 4,000 | No | 0 | 0 |
| S-323 | Cancer Research Center | Warehouse | W | 3,300 | No | 0 | 0 |
| S-324 | NCI-FCRF Central Supply & Trans | Warehouse | W | 7,500 | No | 0 | 0 |
| S-325 | Cancer Research Center | Labratory | L | 12,800 | Yes | 320 | 1,602,000 |
| 326 | USDA | Storage | W | 200 | No | 0 | 0 |
| S-347 | Cancer Research Center | Chemical Storage | W | 2,000 | No | 0 | 0 |
| 349 | Cancer Research Center | Office | O | 3,000 | No | 0 | 0 |
| S-350 | Cancer Research Center | Office/Maintenance | O | 9,300 | No | 0 | 0 |
| S-361 | Cancer Research Center | Maintenance Shop | W | 11,400 | No | 0 | 0 |
| T-362 | Cancer Research Center | Office | O | 9,400 | No | 0 | 0 |
| 374 | USDA | Lab | L | 18,400 | Yes | 460 | 2,304,000 |
| 375 | Steam Sterilization Plant | Shop | O | 21,200 | No | 0 | 0 |
| 376 | Cancer Research Center | Labratory | L | 31,300 | Yes | 780 | 3,919,000 |
| 393 | Incinerator | Incinerator | L | 7,600 | No | 0 | 0 |
| S-426 | CRC-Safety Protective Services | Offices/Med | O | 6,800 | No | 0 | 0 |
| 427 | Cancer Research Center | Office | O | 6,000 | No | 0 | 0 |
| 428 | Cancer Research Center | Office | O | 7,400 | No | 0 | 0 |
| 429 | Cancer Research Center | Lab | L | 6,400 | Yes | 160 | 801,000 |
| 430 | Cancer Research Center | Office | O | 6,000 | No | 0 | 0 |
| 431 | Cancer Research Center | Lab | L | 12,000 | Yes | 300 | 1,502,000 |
| S-432 | Cancer Research Center | Lab | L | 21,500 | Yes | 530 | 2,692,000 |
| S-433 | Cancer Research Center | Lab | L | 5,800 | No | 0 | 0 |
| S-434 | CRC - Fermentation | Offices/Lab | O | 13,800 | No | 0 | 0 |
| S-459 | Cancer Research Center | Warehouse/Shop | O | 10,200 | No | 0 | 0 |
| 469 | Cancer Research Center | Labratory | L | 56,100 | Yes | 1,390 | 7,023,000 |
| 472 | Cancer Research Center | Labratory | L | 6,500 | No | 0 | 0 |
| T-501 | Education/Library | Office | O | 7,600 | No | 0 | 0 |
| S-504 | USAMRDC | Office | O | 9,800 | No | 0 | 0 |
| S-505 | HQ USAMRDC | Office | O | 3,900 | No | 0 | 0 |
| S-521 | Adm Gen Purp | Office | O | 11,500 | No | 0 | 0 |
| S-522 | Cancer Research Center | Labratory | L | 13,000 | Yes | 320 | 1,628,000 |
| S-524 | USAMBRDL Admin | Office | L | 5,300 | No | 0 | 0 |
| S-525 | Adm Gen Purp | Office | O | 6,500 | No | 0 | 0 |
| 538 | Cancer Research Center | Labratory | L | 64,200 | Yes | 1,590 | 8,037,000 |

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.3.1**
**ESTIMATE OF TOTAL STEAM USE FOR REHEATS**

| Bldg. No. | Building Name | Building Use | Building Type | Building SF | Reheat | Peak Lb/Hr | Annual Lb/Yr |
|---|---|---|---|---|---|---|---|
| 539 | CRC-Leroy D. Fothergill Lab | Lab | L | 110,400 | Yes | 2,740 | 13,821,000 |
| 549 | Cancer Research Center | Library | O | 15,000 | No | 0 | 0 |
| 550 | Cancer Research Center | Labratory | L | 20,000 | Yes | 500 | 2,504,000 |
| 560 | Cancer Research Center | Labratory | L | 170,000 | Yes | 4,220 | 21,283,000 |
| 562 | Cancer Research Center | Labratory | L | 15,000 | Yes | 370 | 1,878,000 |
| 567 | Cancer Research Center | Lab | L | 33,000 | Yes | 820 | 4,131,000 |
| 568 | Biomedical R&D lab | Lab | L | 49,300 | Yes | 1,220 | 6,172,000 |
| 571 | CRC-ANIMAL BUILDINGS | Labratory | L | 35,700 | Yes | 890 | 4,469,000 |
| 576 | CRC-Biological Response Modifiers | Office | O | 2,200 | No | 0 | 0 |
| T-611 | William Strough Auditorium | Auditorium w/stage | L | 5,200 | No | 0 | 0 |
| S-660 | Visiting Officers Quarters | Residence | O | 12,200 | No | 0 | 0 |
| T-701 | | Office | O | 2,000 | No | 0 | 0 |
| T-703 | Fire Station | | O | 2,300 | No | 0 | 0 |
| T-713 | Post Exchange | Post Exchange | O | 9,600 | No | 0 | 0 |
| T-715 | Judge Advocate/Legal Assist DVQ R | Office | O | 2,400 | No | 0 | 0 |
| T-718 | Community Club | Community Club | O | 10,500 | No | 0 | 0 |
| T-722 | Adm. Gen Purp. | Office | O | 9,600 | No | 0 | 0 |
| T-817 | ASAMRAA | Office | O | 10,400 | No | 0 | 0 |
| 810 | Administration | Office | O | 34,200 | No | 0 | 0 |
| T-818 | Administration | | O | 2,000 | No | 0 | 0 |
| T-819 | ASAMRAA | Office | O | 1,400 | No | 0 | 0 |
| T-820 | ASAMRAA | Office | O | 7,200 | No | 0 | 0 |
| T-823 | Medical Logistics | Office | O | 2,100 | No | 0 | 0 |
| T-824 | Medical Logistics | Office | O | 2,100 | No | 0 | 0 |
| T-830 | Training Center | Office | O | 7,500 | No | 0 | 0 |
| T-833 | Navy | Office | O | 6,700 | No | 0 | 0 |
| T-834 | Navy | Office | O | 500 | No | 0 | 0 |
| T-835 | | Office | O | 1,600 | No | 0 | 0 |
| T-838 | Field House | Field House/Gym | L | 13,400 | No | 0 | 0 |
| S-839 | Fitness Center | Gym | L | 5,000 | No | 0 | 0 |
| T-901 | Gen. Store House | Warehouse | W | 10,000 | No | 0 | 0 |
| T-902 | Motor Pool | Office | O | 4,600 | No | 0 | 0 |
| T-903 | Motor Pool | Office | O | 2,000 | No | 0 | 0 |
| T-904 | Motor Pool | Office | O | 2,000 | No | 0 | 0 |
| T-914 | PM Adm | Office | O | 3,700 | No | 0 | 0 |
| 915 | Bowling Center | Bowling/Office | O | 5,000 | No | 0 | 0 |
| T-921 | Car Wash/Auto Shop | Shop | W | 3,400 | No | 0 | 0 |
| T-925 | Religious Education | Training/Education | O | 2,100 | No | 0 | 0 |
| 949 | YOUTH CENTER | Youth Center | O | 5,200 | No | 0 | 0 |
| 1021 | Cancer Research Center | Admin/Food Storage | O | 7,500 | No | 0 | 0 |
| 1022-1049 | CRC-ANIMAL BUILDINGS | Animal Storage | L | 36,000 | Yes | 890 | 4,507,000 |
| 1040 | CRC-ANIMAL BUILDINGS | Maintenance | W | 3,000 | No | 0 | 0 |
| 1050 | Cancer Research Center | Warehouse/Offices | W | 40,000 | No | 0 | 0 |
| 1054 | Medical Advance Tech Mgmnt | Office/Warehouse | O | 37,000 | No | 0 | 0 |
| 1301 | USDA | Labs/Offices | L | 39,900 | Yes | 990 | 4,995,000 |
| 1302 | USDA | Labs/Offices | L | 8,800 | Yes | 220 | 1,102,000 |
| 1303 | USDA | Greenhouse | W | 3,700 | No | 0 | 0 |
| 1304 | USDA | Greenhouse | W | 3,700 | No | 0 | 0 |
| 1305 | USDA | Greenhouse | W | 3,700 | No | 0 | 0 |
| 1306 | USDA | Greenhouse | W | 3,700 | No | 0 | 0 |
| 1412 | USAMRIID ANNEX | Lab | L | 70,000 | Yes | 1,740 | 8,764,000 |
| 1414 | USAMRIID ANNEX | Warehouse | W | 2,000 | No | 0 | 0 |
| 1422 | DATA PROCESSING | Office | O | 11,200 | No | 0 | 0 |
| 1425 | USAMRIID ANNEX | Lab | L | 224,100 | Yes | 5,570 | 28,056,000 |
| 1430 | ENLISTED BARRACKS | Residence | O | 38,200 | No | 0 | 0 |
| 1520 | Commisary | Commisary | O | 40,100 | No | 0 | 0 |
| | | | | 1,765,900 | | 26,020 | 131,190,000 |

## 5.4 Humidification

In the winter time, cold outside air holds very little moisture. Moisture must be added to the air in buildings that require large amounts of outside air in the winter. At Fort Detrick this humidification is accomplished by injecting steam directly into the air.

Another big assumption

Steam use for humidification was assumed to occur in animal buildings, or buildings with animal labs, in Buildings 1412 and 1425 (USARMIID), and in Building 915 (the Bowling Center). Humidification was assumed to be necessary in part of December, all of January, February, and March, and in part of April.

The amount of steam used for humidification is based on the square footage of the building and the amount of ventilation required. The areas requiring humidification are typically labs which are assumed to have a 1.15 cfm/sf ventilation rate. The peak amount of steam used for ventilation at any point in time is therefore:

$$Peak = sf \times 1.15 \frac{cfm}{sf} \times 0.075 \frac{lb}{ft^3} \times 60 \frac{Min}{hr} \times 0.008 \frac{lbmoisture}{lbsteam}$$

Humidification is added to the ventilation air on an as needed basis. For the purpose of estimating the amount of steam used, it was assumed that humidification is required about 50% of the time. Annual steam use for humidification is therefore:

$$Annual = 0.50 \times Peak \times 24 \frac{hrs}{day} \times 30 \frac{days}{mo} \times 4\ Full\ Months$$

Table 5.4.1 on the following pages shows the Humidification Model. The model includes the name and number of each building connected to the steam system, building use and building type. The table lists the square footage of each building and whether or not the building has an animal lab. The last two columns show the calculated peak and annual steam use for humidification.

The total steam use for humidification at Fort Detrick has been estimated to be 39 million pounds per year.

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.4.1**
**ESTIMATE OF TOTAL STEAM USE FOR HUMIDIFICATION**

| Bldg. No. | Building Name | Building Use | Building Type | Building SF | Animal Lab | Peak Lb/Hr | Annual Lb/Yr |
|---|---|---|---|---|---|---|---|
| S-10 | Signal Service | Office | O | 4,600 | No | 0 | 0 |
| S-11 | Thrift Shop | Store | O | 3,000 | No | 0 | 0 |
| S-12 | Signal Service | Empty? | O | 1,000 | No | 0 | 0 |
| S-100 | Outside Electric Shop | Warehouse/Shop/Office | W | 5,000 | No | 0 | 0 |
| S-101 | Sewage Pump | | W | 800 | No | 0 | 0 |
| S-122 | Rodent/Pest Control | Storage | W | 1,100 | No | 0 | 0 |
| 190 | BOILER PLANT | | O | 11,200 | No | 0 | 0 |
| S-199 | FE Mnt. Shop | Wharehouse/Shop | W | 12,100 | No | 0 | 0 |
| 200 | | Equipment Shed | W | 1,200 | No | 0 | 0 |
| S-201 | Engineering Offices | Offices | O | 25,300 | No | 0 | 0 |
| T-239 | Cancer Research Center | Warehouse | W | 10,000 | No | 0 | 0 |
| S-243 | Fe Sths | Warehouse/Shop | W | 6,600 | No | 0 | 0 |
| S-244 | Cancer Research Center | Office | O | 5,100 | No | 0 | 0 |
| T-248 | Cancer Research Center | Warehouse | W | 4,800 | No | 0 | 0 |
| T-249 | Cancer Research Center | Warehouse | W | 4,800 | No | 0 | 0 |
| S-261 | Radiology | Labratory | L | 2,500 | No | 0 | 0 |
| S-262 | Gen. Storehouse | Warehouse | W | 5,000 | No | 0 | 0 |
| S-263 | Fe Mnt Shop | Mech Shops/Storehouse | W | 13,900 | No | 0 | 0 |
| S-312 | CRC - Fermentation Production Facility | | W | 400 | No | 0 | 0 |
| S-313 | CRC - Fermentation Production Facility | | L | 2,300 | No | 0 | 0 |
| 314 | Cancer Research Center | Warehouse/Shop | W | 3,800 | No | 0 | 0 |
| S-318 | | Warehouse | W | 3,300 | No | 0 | 0 |
| S-319 | | Warehouse | W | 3,300 | No | 0 | 0 |
| S-321 | Cancer Research Center | Office | O | 4,000 | No | 0 | 0 |
| S-322 | Cancer Research Center | Office | O | 4,000 | No | 0 | 0 |
| S-323 | Cancer Research Center | Warehouse | W | 3,300 | No | 0 | 0 |
| S-324 | NCI-FCRF Central Supply & Trans | Warehouse | W | 7,500 | No | 0 | 0 |
| S-325 | Cancer Research Center | Labratory | L | 12,800 | No | 0 | 0 |
| 326 | USDA | Storage | W | 200 | No | 0 | 0 |
| S-347 | Cancer Research Center | Chemical Storage | W | 2,000 | No | 0 | 0 |
| 349 | Cancer Research Center | Office | O | 3,000 | No | 0 | 0 |
| S-350 | Cancer Research Center | Office/Maintenance | O | 9,300 | No | 0 | 0 |
| S-361 | Cancer Research Center | Maintenance Shop | W | 11,400 | No | 0 | 0 |
| T-362 | Cancer Research Center | Office | O | 9,400 | No | 0 | 0 |
| 374 | USDA | Lab | L | 18,400 | No | 0 | 0 |
| 375 | Steam Sterilization Plant | Shop | O | 21,200 | No | 0 | 0 |
| 376 | Cancer Research Center | Labratory | L | 31,300 | Yes | 1,300 | 1,872,000 |
| 393 | Incinerator | Incinerator | L | 7,600 | No | 0 | 0 |
| S-426 | CRC-Safety Protective Services | Offices/Med | O | 6,800 | No | 0 | 0 |
| 427 | Cancer Research Center | Office | O | 6,000 | No | 0 | 0 |
| 428 | Cancer Research Center | Office | O | 7,400 | No | 0 | 0 |
| 429 | Cancer Research Center | Lab | L | 6,400 | Yes | 260 | 374,000 |
| 430 | Cancer Research Center | Office | O | 6,000 | No | 0 | 0 |
| 431 | Cancer Research Center | Lab | L | 12,000 | No | 0 | 0 |
| S-432 | Cancer Research Center | Lab | L | 21,500 | No | 0 | 0 |
| S-433 | Cancer Research Center | Lab | L | 5,800 | No | 0 | 0 |
| S-434 | CRC - Fermentation | Offices/Lab | O | 13,800 | No | 0 | 0 |
| S-459 | Cancer Research Center | Warehouse/Shop | O | 10,200 | No | 0 | 0 |
| 469 | Cancer Research Center | Labratory | L | 56,100 | No | 0 | 0 |
| 472 | Cancer Research Center | Labratory | L | 6,500 | No | 0 | 0 |
| T-501 | Education/Library | Office | O | 7,600 | No | 0 | 0 |
| S-504 | USAMRDC | Office | O | 9,800 | No | 0 | 0 |
| S-505 | HQ USAMRDC | Office | O | 3,900 | No | 0 | 0 |
| S-521 | Adm Gen Purp | Office | O | 11,500 | No | 0 | 0 |
| S-522 | Cancer Research Center | Labratory | L | 13,000 | Yes | 540 | 778,000 |
| S-524 | USAMBRDL Admin | Office | L | 5,300 | No | 0 | 0 |
| S-525 | Adm Gen Purp | Office | O | 6,500 | No | 0 | 0 |
| 538 | Cancer Research Center | Labratory | L | 64,200 | Yes | 2,660 | 3,830,000 |

## FORT DETRICK
### FREDERICK, MARYLAND
### Table 5.4.1
### ESTIMATE OF TOTAL STEAM USE FOR HUMIDIFICATION

| Bldg. No. | Building Name | Building Use | Building Type | Building SF | Animal Lab | Peak Lb/Hr | Annual Lb/Yr |
|---|---|---|---|---|---|---|---|
| 539 | CRC-Leroy D. Fothergill Lab | Lab | L | 110,400 | Yes | 4,570 | 6,581,000 |
| 549 | Cancer Research Center | Library | O | 15,000 | No | 0 | 0 |
| 550 | Cancer Research Center | Labratory | L | 20,000 | Yes | 830 | 1,195,000 |
| 560 | Cancer Research Center | Labratory | L | 170,000 | No | 0 | 0 |
| 562 | Cancer Research Center | Labratory | L | 15,000 | No | 0 | 0 |
| 567 | Cancer Research Center | Lab | L | 33,000 | Yes | 1,370 | 1,973,000 |
| 568 | Biomedical R&D lab | Lab | L | 49,300 | No | 0 | 0 |
| 571 | CRC-ANIMAL BUILDINGS | Labratory | L | 35,700 | Yes | 1,480 | 2,131,000 |
| 576 | CRC-Biological Response Modifiers | Office | O | 2,200 | No | 0 | 0 |
| T-611 | William Strough Auditorium | Auditorium w/stage | L | 5,200 | No | 0 | 0 |
| S-660 | Visiting Officers Quarters | Residence | O | 12,200 | No | 0 | 0 |
| T-701 | | Office | O | 2,000 | No | 0 | 0 |
| T-703 | Fire Station | | O | 2,300 | No | 0 | 0 |
| T-713 | Post Exchange | Post Exchange | O | 9,600 | No | 0 | 0 |
| T-715 | Judge Advocate/Legal Assist DVQ R | Office | O | 2,400 | No | 0 | 0 |
| T-718 | Community Club | Community Club | O | 10,500 | No | 0 | 0 |
| T-722 | Adm. Gen Purp. | Office | O | 9,600 | No | 0 | 0 |
| T-817 | ASAMRAA | Office | O | 10,400 | No | 0 | 0 |
| 810 | Administration | Office | O | 34,200 | No | 0 | 0 |
| T-818 | Administration | | O | 2,000 | No | 0 | 0 |
| T-819 | ASAMRAA | Office | O | 1,400 | No | 0 | 0 |
| T-820 | ASAMRAA | Office | O | 7,200 | No | 0 | 0 |
| T-823 | Medical Logistics | Office | O | 2,100 | No | 0 | 0 |
| T-824 | Medical Logistics | Office | O | 2,100 | No | 0 | 0 |
| T-830 | Training Center | Office | O | 7,500 | No | 0 | 0 |
| T-833 | Navy | Office | O | 6,700 | No | 0 | 0 |
| T-834 | Navy | Office | O | 500 | No | 0 | 0 |
| T-835 | | Office | O | 1,600 | No | 0 | 0 |
| T-838 | Field House | Field House/Gym | L | 13,400 | No | 0 | 0 |
| S-839 | Fitness Center | Gym | L | 5,000 | No | 0 | 0 |
| T-901 | Gen. Store House | Warehouse | W | 10,000 | No | 0 | 0 |
| T-902 | Motor Pool | Office | O | 4,600 | No | 0 | 0 |
| T-903 | Motor Pool | Office | O | 2,000 | No | 0 | 0 |
| T-904 | Motor Pool | Office | O | 2,000 | No | 0 | 0 |
| T-914 | PM Adm | Office | O | 3,700 | No | 0 | 0 |
| 915 | Bowling Center | Bowling/Office | O | 5,000 | No | 210 | 302,000 |
| T-921 | Car Wash/Auto Shop | Shop | W | 3,400 | No | 0 | 0 |
| T-925 | Religious Education | Training/Education | O | 2,100 | No | 0 | 0 |
| 949 | YOUTH CENTER | Youth Center | O | 5,200 | No | 0 | 0 |
| 1021 | Cancer Research Center | Admin/Food Storage | O | 7,500 | No | 0 | 0 |
| 1022-1049 | CRC-ANIMAL BUILDINGS | Animal Storage | L | 36,000 | Yes | 1,490 | 2,146,000 |
| 1040 | CRC-ANIMAL BUILDINGS | Maintenance | W | 3,000 | No | 0 | 0 |
| 1050 | Cancer Research Center | Warehouse/Offices | W | 40,000 | No | 0 | 0 |
| 1054 | Medical Advance Tech Mgmnt | Office/Warehouse | O | 37,000 | No | 0 | 0 |
| 1301 | USDA | Labs/Offices | L | 39,900 | No | 0 | 0 |
| 1302 | USDA | Labs/Offices | L | 8,800 | No | 0 | 0 |
| 1303 | USDA | Greenhouse | W | 3,700 | No | 0 | 0 |
| 1304 | USDA | Greenhouse | W | 3,700 | No | 0 | 0 |
| 1305 | USDA | Greenhouse | W | 3,700 | No | 0 | 0 |
| 1306 | USDA | Greenhouse | W | 3,700 | No | 0 | 0 |
| 1412 | USAMRIID ANNEX | Lab | L | 70,000 | No | 2,900 | 4,176,000 |
| 1414 | USAMRIID ANNEX | Warehouse | W | 2,000 | No | 0 | 0 |
| 1422 | DATA PROCESSING | Office | O | 11,200 | No | 0 | 0 |
| 1425 | USAMRIID ANNEX | Lab | L | 224,100 | No | 9,280 | 13,363,000 |
| 1430 | ENLISTED BARRACKS | Residence | O | 38,200 | No | 0 | 0 |
| 1520 | Commisary | Commisary | O | 40,100 | No | 0 | 0 |
| | | | | 1,765,900 | | 26,890 | 38,721,000 |

## 5.5 Domestic Hot Water

The principle user of domestic hot water at Fort Detrick is the animal buildings and labs where employees must shower when they arrive to work and shower at the end of the day. A smaller amount of steam is used in office buildings for hand washing, coffee, etc. The following assumptions were used to estimate steam use for domestic hot water.

| | Office | Lab | Animal Lab |
|---|---|---|---|
| No. People/Gross square foot | 1/350 | 1/500 | 1/500 |
| Average Gallon Hot Water/ Person/Day | 1 | 5 | 50 |

The expected peak and annual steam use for domestic hot water is then calculated as follows:

$$Peak = \left( \frac{(sf\ x\ \frac{people}{sf})\ (Gal/\frac{Person}{Day})\ \ (0.4\ \ Diversity)\ (8.3\frac{lb}{gal})\ (1\ \ \frac{Btu}{lb^\circ F})\ (60^\circ F)}{1{,}000\ \frac{Btu}{lbsteam}} \right)$$

$$Annual = \left( \frac{(sf\ x\ \frac{people}{sf})\ (Gal/\frac{Person}{Day})\ (365\frac{Day}{yr})\ (8.3\ \frac{lb}{gal})\ (1\ \ \frac{Btu}{lb^\circ F})\ (60^\circ F)}{1{,}000\frac{Btu}{lbsteam}} \right)$$

For example, Building 321 is a 6,300 square foot office that uses steam for heating domestic hot water. The building is assumed to have 18 people (6,300 sf ÷350 sf/person) working in it. The steam required to provide hot water for these people is calculated as follows:

$$Peak = \left( \frac{(18\ people)\ (1 \frac{GalPerson}{Day})\ (0.4\ Diversity)\ (8.3\ \frac{lb}{gal})\ (1\ \frac{Btu}{lb^\circ F})\ (60^\circ F)}{1{,}000\ \frac{Btu}{lb}} \right) = 4\ \frac{lb}{hr}$$

$$Annual = \left( \frac{(18\ people)\ (1\ \frac{galperson}{day})\ (365 Days)\ (8.3\ \frac{lb}{gal})\ (1\ \frac{Btu}{lb^\circ F})\ (60^\circ F)}{1{,}000\ \frac{Btu}{lb}} \right) = 3{,}000\ \frac{lb}{yr}$$

The steam use for domestic hot water is modeled in Table 5.5.1 shown on the following pages.

Fort Detrick has converted many of the office buildings on the base to electric domestic hot water and abandoned the use of steam for heating water. These buildings will indicate "NO" in the column indicating if there is domestic hot water.

FORT DETRICK

FREDERICK, MARYLAND

Table 5.5.1

ESTIMATE OF TOTAL STEAM USE FOR DOMESTIC HOT WATER

| Bldg. No. | Building Name | Building Use | Building Type | Building SF | Est. No. People | Animal Lab | Dom. Hot Water | Peak Lb/Hr | Annual Lb/Yr |
|---|---|---|---|---|---|---|---|---|---|
| S-10 | Signal Service | Office | O | 4,600 | 13 | No | No | 0 | 0 |
| S-11 | Thrift Shop | Store | O | 3,000 | 9 | No | No | 0 | 0 |
| S-12 | Signal Service | Empty? | O | 1,000 | 3 | No | No | 0 | 0 |
| S-100 | Outside Electric Shop | Warehouse/Shop/Office | W | 5,000 | 0 | No | No | 0 | 0 |
| S-101 | Sewage Pump | | W | 800 | 0 | No | No | 0 | 0 |
| S-122 | Rodent/Pest Control | Storage | W | 1,100 | 0 | No | No | 0 | 0 |
| 190 | BOILER PLANT | | O | 11,200 | 32 | No | No | 0 | 0 |
| S-199 | FE Mnt. Shop | Wharehouse/Shop | W | 12,100 | 0 | No | No | 0 | 0 |
| 200 | | Equipment Shed | W | 1,200 | 0 | No | No | 0 | 0 |
| S-201 | Engineering Offices | Offices | O | 25,300 | 72 | No | No | 0 | 0 |
| T-239 | Cancer Research Center | Warehouse | W | 10,000 | 0 | No | No | 0 | 0 |
| S-243 | Fe Sths | Warehouse/Shop | W | 6,600 | 0 | No | No | 0 | 0 |
| S-244 | Cancer Research Center | Office | O | 5,100 | 15 | No | No | 0 | 0 |
| T-248 | Cancer Research Center | Warehouse | W | 4,800 | 0 | No | No | 0 | 0 |
| T-249 | Cancer Research Center | Warehouse | W | 4,800 | 0 | No | No | 0 | 0 |
| S-261 | Radiology | Labratory | L | 2,500 | 5 | No | No | 0 | 0 |
| S-262 | Gen. Storehouse | Warehouse | W | 5,000 | 0 | No | No | 0 | 0 |
| S-263 | Fe Mnt Shop | Mech Shops/Storehouse | W | 13,900 | 0 | No | No | 0 | 0 |
| S-312 | CRC - Fermentation Production Facility | | W | 400 | 0 | No | No | 0 | 0 |
| S-313 | CRC - Fermentation Production Facility | | L | 2,300 | 5 | No | Yes | 5 | 4,000 |
| 314 | Cancer Research Center | Warehouse/Shop | W | 3,800 | 0 | No | No | 0 | 0 |
| S-318 | | Warehouse | W | 3,300 | 0 | No | No | 0 | 0 |
| S-319 | | Warehouse | W | 3,300 | 0 | No | No | 0 | 0 |
| S-321 | Cancer Research Center | Office | O | 4,000 | 11 | No | Yes | 2 | 2,000 |
| S-322 | Cancer Research Center | Office | O | 4,000 | 11 | No | Yes | 2 | 2,000 |
| S-323 | Cancer Research Center | Warehouse | W | 3,300 | 0 | No | No | 0 | 0 |
| S-324 | NCI-FCRF Central Supply & Trans | Warehouse | W | 7,500 | 0 | No | No | 0 | 0 |
| S-325 | Cancer Research Center | Labratory | L | 12,800 | 26 | No | Yes | 25 | 23,000 |
| 326 | USDA | Storage | W | 200 | 0 | No | No | 0 | 0 |
| S-347 | Cancer Research Center | Chemical Storage | W | 2,000 | 0 | No | No | 0 | 0 |
| 349 | Cancer Research Center | Office | O | 3,000 | 9 | No | Yes | 2 | 2,000 |
| S-350 | Cancer Research Center | Office/Maintenance | O | 9,300 | 27 | No | Yes | 45 | 108,000 |
| S-361 | Cancer Research Center | Maintenance Shop | W | 11,400 | 0 | No | Yes | 40 | 104,000 |
| T-362 | Cancer Research Center | Office | O | 9,400 | 27 | No | Yes | 5 | 5,000 |
| 374 | USDA | Lab | L | 18,400 | 37 | No | Yes | 37 | 33,000 |
| 375 | Steam Sterilization Plant | Shop | O | 21,200 | 61 | No | No | 0 | 0 |
| 376 | Cancer Research Center | Labratory | L | 31,300 | 63 | Yes | Yes | 623 | 569,000 |
| 393 | Incinerator | Incinerator | L | 7,600 | 15 | No | No | 0 | 0 |
| S-426 | CRC-Safety Protective Services | Offices/Med | O | 6,800 | 19 | No | Yes | 4 | 4,000 |
| 427 | Cancer Research Center | Office | O | 6,000 | 17 | No | Yes | 3 | 3,000 |
| 428 | Cancer Research Center | Office | O | 7,400 | 21 | No | Yes | 4 | 4,000 |

## FORT DETRICK
### FREDERICK, MARYLAND
### Table 5.5.1
### ESTIMATE OF TOTAL STEAM USE FOR DOMESTIC HOT WATER

| Bldg. No. | Building Name | Building Use | Building Type | Building SF | Est. No. People | Animal Lab | Dom. Hot Water | Peak Lb/Hr | Annual Lb/Yr |
|---|---|---|---|---|---|---|---|---|---|
| 429 | Cancer Research Center | Lab | L | 6,400 | 13 | Yes | Yes | 127 | 116,000 |
| 430 | Cancer Research Center | Office | O | 6,000 | 17 | No | Yes | 3 | 3,000 |
| 431 | Cancer Research Center | Lab | L | 12,000 | 24 | No | Yes | 24 | 22,000 |
| S-432 | Cancer Research Center | Lab | L | 21,500 | 43 | No | Yes | '43 | 39,000 |
| S-433 | Cancer Research Center | Lab | L | 5,800 | 12 | No | Yes | 12 | 11,000 |
| S-434 | CRC - Fermentation | Offices/Lab | O | 13,800 | 39 | No | Yes | 8 | 7,000 |
| S-459 | Cancer Research Center | Warehouse/Shop | O | 10,200 | 29 | No | Yes | 6 | 5,000 |
| 469 | Cancer Research Center | Labratory | L | 56,100 | 112 | No | Yes | 112 | 102,000 |
| 472 | Cancer Research Center | Labratory | L | 6,500 | 13 | No | Yes | 13 | 12,000 |
| T-501 | Education/Library | Office | O | 7,600 | 22 | No | No | 0 | 0 |
| S-504 | USAMRDC | Office | O | 9,800 | 28 | No | No | 0 | 0 |
| S-505 | HQ USAMRDC | Office | O | 3,900 | 11 | No | No | 0 | 0 |
| S-521 | Adm Gen Purp | Office | O | 11,500 | 33 | No | No | 0 | 0 |
| S-522 | Cancer Research Center | Labratory | L | 13,000 | 26 | Yes | Yes | 259 | 236,000 |
| S-524 | USAMBRDL Admin | Office | L | 5,300 | 11 | No | No | 0 | 0 |
| S-525 | Adm Gen Purp | Office | O | 6,500 | 19 | No | No | 0 | 0 |
| 538 | Cancer Research Center | Labratory | L | 64,200 | 128 | Yes | Yes | 384 | 350,000 |
| 539 | CRC-Leroy D. Fothergill Lab | Lab | L | 110,400 | 221 | Yes | Yes | 2,199 | 2,007,000 |
| 549 | Cancer Research Center | Library | O | 15,000 | 43 | No | Yes | 9 | 8,000 |
| 550 | Cancer Research Center | Labratory | L | 20,000 | 40 | Yes | Yes | 398 | 364,000 |
| 560 | Cancer Research Center | Labratory | L | 170,000 | 340 | No | Yes | 339 | 309,000 |
| 562 | Cancer Research Center | Labratory | L | 15,000 | 30 | No | Yes | 30 | 27,000 |
| 567 | Cancer Research Center | Lab | L | 33,000 | 66 | Yes | Yes | 657 | 600,000 |
| 568 | Biomedical R&D lab | Lab | L | 49,300 | 99 | No | Yes | 98 | 90,000 |
| 571 | CRC-ANIMAL BUILDINGS | Labratory | L | 35,700 | 71 | Yes | Yes | 711 | 649,000 |
| 576 | CRC-Biological Response Modifiers | Office | O | 2,200 | 6 | No | Yes | 1 | 1,000 |
| T-611 | William Strough Auditorium | Auditorium w/stage | L | 5,200 | 10 | No | No | 0 | 0 |
| S-660 | Visiting Officers Quarters | Residence | O | 12,200 | 35 | No | Yes | 7 | 6,000 |
| T-701 | | Office | O | 2,000 | 6 | No | No | 0 | 0 |
| T-703 | Fire Station | | O | 2,300 | 7 | No | No | 0 | 0 |
| T-713 | Post Exchange | Post Exchange | O | 9,600 | 27 | No | No | 0 | 0 |
| T-715 | Judge Advocate/Legal Assist DVQ R | Office | O | 2,400 | 7 | No | No | 0 | 0 |
| T-718 | Community Club | Community Club | O | 10,500 | 30 | No | Yes | 6 | 5,000 |
| T-722 | Adm. Gen Purp. | Office | O | 9,600 | 27 | No | No | 0 | 0 |
| T-817 | ASAMRAA | Office | O | 10,400 | 30 | No | No | 0 | 0 |
| 810 | Administration | Office | O | | 0 | No | No | 0 | 0 |
| T-818 | Administration | | O | 2,000 | 6 | No | No | 0 | 0 |
| T-819 | ASAMRAA | Office | O | 1,400 | 4 | No | No | 0 | 0 |
| T-820 | ASAMRAA | Office | O | 7,200 | 21 | No | No | 0 | 0 |
| T-823 | Medical Logistics | Office | O | 2,100 | 6 | No | No | 0 | 0 |
| T-824 | Medical Logistics | Office | O | 2,100 | 6 | No | No | 0 | 0 |

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.5.1**
**ESTIMATE OF TOTAL STEAM USE FOR DOMESTIC HOT WATER**

| Bldg. No. | Building Name | Building Use | Building Type | Building SF | Est. No. People | Animal Lab | Dom. Hot Water | Peak Lb/Hr | Annual Lb/Yr |
|---|---|---|---|---|---|---|---|---|---|
| T-830 | Training Center | Office | O | 7,500 | 21 | No | No | 0 | 0 |
| T-833 | Navy | Office | O | 6,700 | 19 | No | No | 0 | 0 |
| T-834 | Navy | Office | O | 500 | 1 | No | No | 0 | 0 |
| T-835 | | Office | O | 1,600 | 5 | No | No | 0 | 0 |
| T-838 | Field House | Field House/Gym | L | 13,400 | 27 | No | As Specified | 704 | 3,855,000 |
| S-839 | Fitness Center | Gym | L | 5,000 | 10 | No | As Specified | 278 | 1,525,000 |
| T-901 | Gen. Store House | Warehouse | W | 10,000 | 0 | No | No | 0 | 0 |
| T-902 | Motor Pool | Office | O | 4,600 | 13 | No | No | 0 | 0 |
| T-903 | Motor Pool | Office | O | 2,000 | 6 | No | No | 0 | 0 |
| T-904 | Motor Pool | Office | O | 2,000 | 6 | No | No | 0 | 0 |
| T-914 | PM Adm | Office | O | 3,700 | 11 | No | No | 0 | 0 |
| 915 | Bowling Center | Bowling/Office | O | 5,000 | 14 | No | No | 0 | 0 |
| T-921 | Car Wash/Auto Shop | Shop | W | 3,400 | 0 | No | Yes | 20 | 52,000 |
| T-925 | Religious Education | Training/Education | O | 2,100 | 6 | No | No | 0 | 0 |
| 949 | YOUTH CENTER | Youth Center | O | 5,200 | 15 | No | No | 0 | 0 |
| 1021 | Cancer Research Center | Admin/Food Storage | O | 7,500 | 21 | No | No | 0 | 0 |
| 1022-1049 | CRC-ANIMAL BUILDINGS | Animal Storage | L | 36,000 | 72 | Yes | Yes | 717 | 654,000 |
| 1040 | CRC-ANIMAL BUILDINGS | Maintenance | W | 3,000 | 0 | No | No | 0 | 0 |
| 1050 | Cancer Research Center | Warehouse/Offices | W | 40,000 | 0 | No | No | 0 | 0 |
| 1054 | Medical Advance Tech Mgmnt | Office/Warehouse | O | 37,000 | 106 | No | Yes | 21 | 19,000 |
| 1301 | USDA | Labs/Offices | L | 39,900 | 80 | No | Yes | 79 | 73,000 |
| 1302 | USDA | Labs/Offices | L | 8,800 | 18 | No | Yes | 18 | 16,000 |
| 1303 | USDA | Greenhouse | W | 3,700 | 0 | No | No | 0 | 0 |
| 1304 | USDA | Greenhouse | W | 3,700 | 0 | No | No | 0 | 0 |
| 1305 | USDA | Greenhouse | W | 3,700 | 0 | No | No | 0 | 0 |
| 1306 | USDA | Greenhouse | W | 3,700 | 0 | No | No | 0 | 0 |
| 1412 | USAMRIID ANNEX | Lab | L | 70,000 | 140 | No | Yes | 139 | 127,000 |
| 1414 | USAMRIID ANNEX | Warehouse | W | 2,000 | 0 | No | No | 0 | 0 |
| 1422 | DATA PROCESSING | Office | O | 11,200 | 32 | No | No | 0 | 0 |
| 1425 | USAMRIID ANNEX | Lab | L | 224,100 | 448 | No | Yes | 446 | 407,000 |
| 1430 | ENLISTED BARRACKS | Residence | O | 38,200 | 109 | No | As Specified | 806 | 681,000 |
| 1520 | Commisary | Commisary | O | 40,100 | 115 | No | No | 0 | 0 |
| | | | | 1,731,700 | 3,507 | | | 9,474 | 13,241,000 |

There are numerous special hot water uses at Fort Detrick in addition to those described above. These special hot water uses as described in Table 5.5.2, are included in the Hot Water Model.

**Special Hot Water Uses**
**Table 5.5.2**

| Building | Assumed Load | gal/day | lb/hr | lb/yr |
|---|---|---|---|---|
| 350 CRC-Office/Maintenance | 4 Showers | 200 | 40 | 104,000 |
| 361 CRC-Maintenance Shop | 4 Showers | 200 | 40 | 104,000 |
| 838 Field House | 15 Basins | 720 | 24 | 131,000 |
| | 15 Showers | 20,250 | 672 | 3,681,000 |
| | 2 Wash Machines | 240 | 8 | 44,000 |
| 839 Fitness Center | 6 Basins | 288 | 10 | 52,000 |
| | 6 Showers | 8,100 | 269 | 1,472,000 |
| 921 Car Wash/Auto Shop | 2 Showers | 100 | 20 | 52,000 |
| 1430 Enlisted Barracks * | 4 Wash Machines | 50 | 25 | 9,000 |

* 140 sf/person and 13 gal/person was assumed for domestic hot water use in the enlisted barracks.

Approximately 13 million pounds of steam is used annually for domestic hot water.

## 5.6 Autoclaves/Cage Washers

Autoclaves use a small amount of steam all of the time to keep the steam jacket of the equipment warm and ready for use. This equipment is typically used for only a few hours each day. When it is being used, it draws a much larger amount of steam than when it sits idle.

For the purpose of this analysis, it was assumed that a typical autoclave uses 6 lb/hr of steam to maintain temperature. The autoclaves are assumed to be turned on Monday morning and turned off Friday evening. They are assumed to be used for sterilization about 2 hours each day and are expected to draw 200 lb/hr of steam when in use. The peak and annual steam use by each autoclave is then calculated as follows:

$$Peak = 200\ lb\ x\ 0.4\ diversity = 80\ \frac{lb}{hr}$$

$$Annual = (200\ \frac{lb}{hr})\ (10\ \frac{hr}{wk})\ (52\ \frac{wk}{yr}) + (6\ \frac{lb}{hr})\ (94\ \frac{hr}{wk})\ (52\ \frac{wk}{yr}) = 133{,}300\ \frac{lb}{yr}$$

Diversity is included in the calculation of peak load to account for the fact that there is usually more than one autoclave in each building and they are not expected to operate simultaneously. Large autoclaves are assumed to draw twice as much steam as a typical autoclave. Cage washers and rack washers are assumed to consume 60 lb/hr each when in use. The annual steam use for this equipment is estimated as follows:

Peak = 60 lb/hr x 0.40 Diversity = 24 lb/hr

$$Annual = (60\ \frac{lb}{hr})\ (10\ \frac{hr}{wk})\ (52\ \frac{wk}{yr}) = 31{,}200\ \frac{lb}{yr}$$

Information about the quantity of autoclaves and cage and rack washers was provided by personnel in Fort Detricks Engineering Department and by the National Cancer Institute's Engineering staff. The Autoclave/Cage Washer Model shows the quantity of steam using equipment in each building, and the peak and annual steam consumed by the equipment. The model is shown in Table 5.6.1 on the following pages.

The autoclaves and cage and rack washers consume about 31 million pounds of steam each year.

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.6.1**
**ESTIMATE OF TOTAL STEAM USE BY AUTOCLAVES AND CAGEWASHERS**

| Bldg. No. | Building Name | Building Use | No. of Autoclaves | No. Large Autoclaves | No. of Cage and Rack Washers | Peak Lbs/Hr | Annual Lbs/Yr |
|---|---|---|---|---|---|---|---|
| S-10 | Signal Service | Office | | | | 0 | 0 |
| S-11 | Thrift Shop | Store | | | | 0 | 0 |
| S-12 | Signal Service | Empty? | | | | 0 | 0 |
| S-100 | Outside Electric Shop | Warehouse/Shop/Office | | | | 0 | 0 |
| S-101 | Sewage Pump | | | | | 0 | 0 |
| S-122 | Rodent/Pest Control | Storage | | | | 0 | 0 |
| 190 | BOILER PLANT | | | | | 0 | 0 |
| S-199 | FE Mnt. Shop | Wharehouse/Shop | | | | 0 | 0 |
| 200 | | Equipment Shed | | | | 0 | 0 |
| S-201 | Engineering Offices | Offices | | | | 0 | 0 |
| T-239 | Cancer Research Center | Warehouse | | | | 0 | 0 |
| S-243 | Fe Sths | Warehouse/Shop | | | | 0 | 0 |
| S-244 | Cancer Research Center | Office | | | | 0 | 0 |
| T-248 | Cancer Research Center | Warehouse | | | | 0 | 0 |
| T-249 | Cancer Research Center | Warehouse | | | | 0 | 0 |
| S-261 | Radiology | Labratory | | | | 0 | 0 |
| S-262 | Gen. Storehouse | Warehouse | | | | 0 | 0 |
| S-263 | Fe Mnt Shop | Mech Shops/Storehouse | | | | 0 | 0 |
| S-312 | CRC - Fermentation Production Facility | | | | | 0 | 0 |
| S-313 | CRC - Fermentation Production Facility | | 1 | | | 80 | 133,000 |
| 314 | Cancer Research Center | Warehouse/Shop | | | | 0 | 0 |
| S-318 | | Warehouse | | | | 0 | 0 |
| S-319 | | Warehouse | | | | 0 | 0 |
| S-321 | Cancer Research Center | Office | | | | 0 | 0 |
| S-322 | Cancer Research Center | Office | | | | 0 | 0 |
| S-323 | Cancer Research Center | Warehouse | | | | 0 | 0 |
| S-324 | NCI-FCRF Central Supply & Trans | Warehouse | | | | 0 | 0 |
| S-325 | Cancer Research Center | Labratory | 4 | | | 320 | 533,000 |
| 326 | USDA | Storage | | | | 0 | 0 |
| S-347 | Cancer Research Center | Chemical Storage | | | | 0 | 0 |
| 349 | Cancer Research Center | Office | | | | 0 | 0 |
| S-350 | Cancer Research Center | Office/Maintenance | | | | 0 | 0 |
| S-361 | Cancer Research Center | Maintenance Shop | | | | 0 | 0 |
| T-362 | Cancer Research Center | Office | | | | 0 | 0 |
| 374 | USDA | Lab | 5 | | | 400 | 667,000 |
| 375 | Steam Sterilization Plant | Shop | 2 | | | 160 | 267,000 |
| 376 | Cancer Research Center | Labratory | 16 | 3 | 4 | 1,860 | 3,058,000 |
| 393 | Incinerator | Incinerator | | | | 0 | 0 |
| S-426 | CRC-Safety Protective Services | Offices/Med | 1 | | | 80 | 133,000 |
| 427 | Cancer Research Center | Office | | | | 0 | 0 |
| 428 | Cancer Research Center | Office | | | | 0 | 0 |

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**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.6.1**
**ESTIMATE OF TOTAL STEAM USE BY AUTOCLAVES AND CAGEWASHERS**

| Bldg. No. | Building Name | Building Use | No. of Autoclaves | No. Large Autoclaves | No. of Cage and Rack Washers | Peak Lbs/Hr | Annual Lbs/Yr |
|---|---|---|---|---|---|---|---|
| 429 | Cancer Research Center | Lab | 3 | | 1 | 260 | 431,000 |
| 430 | Cancer Research Center | Office | | | | 0 | 0 |
| 431 | Cancer Research Center | Lab | | 3 | | 480 | 800,000 |
| S-432 | Cancer Research Center | Lab | 1 | | | 80 | 133,000 |
| S-433 | Cancer Research Center | Lab | 2 | | | 160 | 267,000 |
| S-434 | CRC - Fermentation | Offices/Lab | 2 | | | 160 | 267,000 |
| S-459 | Cancer Research Center | Warehouse/Shop | | | | 0 | 0 |
| 469 | Cancer Research Center | Labratory | 2 | 3 | | 640 | 1,067,000 |
| 472 | Cancer Research Center | Labratory | 1 | | | 80 | 133,000 |
| T-501 | Education/Library | Office | | | | 0 | 0 |
| S-504 | USAMRDC | Office | | | | 0 | 0 |
| S-505 | HQ USAMRDC | Office | | | | 0 | 0 |
| S-521 | Adm Gen Purp | Office | | | | 0 | 0 |
| S-522 | Cancer Research Center | Labratory | 4 | 1 | 2 | 530 | 862,000 |
| S-524 | USAMBRDL Admin | Office | | | | 0 | 0 |
| S-525 | Adm Gen Purp | Office | | | | 0 | 0 |
| 538 | Cancer Research Center | Labratory | 6 | | 4 | 580 | 925,000 |
| 539 | CRC-Leroy D. Fothergill Lab | Lab | 10 | 5 | 7 | 1,770 | 2,885,000 |
| 549 | Cancer Research Center | Library | | | | 0 | 0 |
| 550 | Cancer Research Center | Labratory | 4 | | 2 | 370 | 596,000 |
| 560 | Cancer Research Center | Labratory | 30 | | | 2,400 | 4,000,000 |
| 562 | Cancer Research Center | Labratory | | | | 0 | 0 |
| 567 | Cancer Research Center | Offices/Labs | 1 | 2 | 2 | 450 | 729,000 |
| 568 | Biomedical R&D lab | Lab | | | | 0 | 0 |
| 571 | CRC-ANIMAL BUILDINGS | Labratory | 1 | 3 | 2 | 610 | 996,000 |
| 576 | ] | Office | | | | 0 | 0 |
| T-611 | William Strough Auditorium | Auditorium w/stage | | | | 0 | 0 |
| S-660 | Visiting Officers Quarters | Residence | | | | 0 | 0 |
| T-701 | | Office | | | | 0 | 0 |
| T-703 | Fire Station | | | | | 0 | 0 |
| T-713 | Post Exchange | Post Exchange | | | | 0 | 0 |
| T-715 | Judge Advocate/Legal Assist DVQ Residenc | Office | | | | 0 | 0 |
| T-718 | Community Club | Community Club | | | | 0 | 0 |
| T-722 | Adm. Gen Purp. | Office | | | | 0 | 0 |
| T-817 | ASAMRAA | Office | | | | 0 | 0 |
| 810 | Administration | Office | | | | 0 | 0 |
| T-818 | Administration | | | | | 0 | 0 |
| T-819 | ASAMRAA | Office | | | | 0 | 0 |
| T-820 | ASAMRAA | Office | | | | 0 | 0 |
| T-823 | Medical Logistics | Office | | | | 0 | 0 |
| T-824 | Medical Logistics | Office | | | | 0 | 0 |

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.6.1**
**ESTIMATE OF TOTAL STEAM USE BY AUTOCLAVES AND CAGEWASHERS**

| Bldg. No. | Building Name | Building Use | No. of Autoclaves | No. Large Autoclaves | No. of Cage and Rack Washers | Peak Lbs/Hr | Annual Lbs/Yr |
|---|---|---|---|---|---|---|---|
| T-830 | Training Center | Office | | | | 0 | 0 |
| T-833 | Navy | Office | | | | 0 | 0 |
| T-834 | Navy | Office | | | | 0 | 0 |
| T-835 | | Office | | | | 0 | 0 |
| T-838 | Field House | Field House/Gym | | | | 0 | 0 |
| S-839 | Fitness Center | Gym | | | | 0 | 0 |
| T-901 | Gen. Store House | Warehouse | | | | 0 | 0 |
| T-902 | Motor Pool | Office | | | | 0 | 0 |
| T-903 | Motor Pool | Office | | | | 0 | 0 |
| T-904 | Motor Pool | Office | | | | 0 | 0 |
| T-914 | PM Adm | Office | | | | 0 | 0 |
| 915 | Bowling Center | Bowling/Office | | | | 0 | 0 |
| T-921 | Car Wash/Auto Shop | Shop | | | | 0 | 0 |
| T-925 | Religious Education | Training/Education | | | | 0 | 0 |
| 949 | YOUTH CENTER | Youth Center | | | | 0 | 0 |
| 1021 | Cancer Research Center | Admin/Food Storage | | | 2 | 50 | 62,000 |
| 1022-1049 | CRC-ANIMAL BUILDINGS | Animal Storage | 21 | 4 | | 2,320 | 3,867,000 |
| 1040 | CRC-ANIMAL BUILDINGS | Maintenance | | | | 0 | 0 |
| 1050 | Cancer Research Center | Warehouse/Offices | | | | 0 | 0 |
| 1054 | Medical Advance Tech Mgmnt | Office/Warehouse | | | | 0 | 0 |
| 1301 | USDA | Labs/Offices | 12 | | | 960 | 1,600,000 |
| 1302 | USDA | Labs/Offices | | | | 0 | 0 |
| 1303 | USDA | Greenhouse | | | | 0 | 0 |
| 1304 | USDA | Greenhouse | | | | 0 | 0 |
| 1305 | USDA | Greenhouse | | | | 0 | 0 |
| 1306 | USDA | Greenhouse | | | | 0 | 0 |
| 1412 | USAMRIID ANNEX | Lab | 10 | | | 800 | 1,333,000 |
| 1414 | USAMRIID ANNEX | Warehouse | | | | 0 | 0 |
| 1422 | DATA PROCESSING | Office | | | | 0 | 0 |
| 1425 | USAMRIID ANNEX | Lab | 39 | | | 3,120 | 5,200,000 |
| 1430 | ENLISTED BARRACKS | Residence | | | | 0 | 0 |
| 1520 | Commisary | Commisary | | | | 0 | 0 |
| | | | 178 | 24 | 26 | 18,720 | 30,944,000 |

## 5.7 Sewage Decontamination

Fort Detrick has a contaminated sewage system to collect the sewage stream from areas on the base where potentially dangerous waste might be found. The contaminated sewage is treated in Building 375, the Steam Sterilization Plant. Contaminated sewage is considered treated when its temperature is raised to 280°F. The method of doing this is by directly injecting 100 psig steam into preheated sewage at 245°F. The incoming contaminated sewage is assumed to enter the process at 85°F It is then routed through a serious of heat exchangers until it reaches 245°F. The heat exchangers recover heat from the treated contaminated sewage prior to its release to the normal sewage system at a temperature of 120°F.

The steam required to raise the temperature from 245°F to 280°F is estimated by determining the factor (f) of lbs of steam required per lbs of sewage.

Contaminated sewage at 245°F + Sat. sewage at 100 psig = Cont. sewage at 285°F

$$(1 - f)\ (213\ \frac{btu}{lbm}) + (f)\ (880\ \frac{btu}{lbm}) = (1)\ (248\ \frac{btu}{lbm})$$

$$f = \left(248\ \frac{btu}{lbm} - 213\ \frac{btu}{lbm}\right) / \left(880\ \frac{btu}{lbm} - 213\right)$$

$$f = 0.0619\ \frac{lbs}{steam} / \frac{lb}{sewage}$$

Example: The total steam required for treating contaminated sewage during January 1994 is estimated to be 2,909,600 lbs.

$$5{,}666{,}400 \ \frac{gal}{yr} \ X \ \frac{8.3 \ lbs}{gal} \ X \ 0.0619 \ \frac{lbs \ steam}{lbs \ sewage} = 2{,}909{,}600 \ \frac{lbs}{yr}$$

Fort Detrick provided meter data for the amount of sewage passing through Building 375 on a monthly basis between October 1993 and September 1994. The amount of steam required to treat the sewage was calculated from this data and is shown in Table 5.7.1. The estimated total is 45 million pounds of steam per year.

**Steam Use for Sewage Decontamination**
**Table 5.7.1**

| Month/Year | Metered Sewage (Gallons) | Total Steam (lbs) |
|---|---|---|
| October 1993 | 8,230,000 | 4,226,000 |
| November | 5,839,200 | 2,998,300 |
| December | 6,112,800 | 3,138,800 |
| January 1994 | 5,666,400 | 2,909,600 |
| February | 4,730,400 | 2,429,000 |
| March | 5,972,700 | 3,051,500 |
| April | 6,797,100 | 3,490,200 |
| May | 7,070,400 | 3,630,600 |
| June | 8,243,400 | 4,232,900 |
| July | 10,036,200 | 5,153,400 |
| August | 11,713,500 | 6,014,700 |
| September | 7,940,400 | 4,077,300 |
| **Total** | **88,352,500** | **45,352,300** |

## 5.8 Other Process Steam Loads

The remaining steam users at Fort Detrick have been classified as other process steam loads. These loads include glass washers, kitchen steam use and a still used to make distilled water. Table 5.8.1 describes the "other process" identified in each building.

**Other Process Steam Loads**
**Table 5.8.1**

| Building | Process Load | Steam Load lb/hr | Annual Steam lb/yr |
|---|---|---|---|
| 325 CRC-Laboratory | 2 Glass Washers | 50 | 62,000 |
| 374 USDA - Lab | Distillery | 100 | 10,000 |
| 375 Steam Sterilization Plant | Distillery | 230 | 35,000 |
| 431 CRC-Laboratory | 2 Glass Washers | 50 | 62,000 |
| 469 CRC-Laboratory | 5 Glass Washers | 120 | 156,000 |
| 567 CRC-Laboratory | 2 Glass Washers | 50 | 62,000 |
| 568 Biomedical R&D Lab | Distillery | 240 | 25,000 |
| 571 CRC-Animal Building | 2 Glass Washers | 50 | 62,000 |
| 1301 USDA - Lab | 1 Glass Washer | 20 | 31,000 |
| 1301 USDA - Lab | Distillery | 240 | 25,000 |
| 1412 USAMRIID | Distillery | 1,930 | 704,000 |
| 1430 Enlisted Barracks | Kitchen | 220 | 482,000 |
| **Total** | | **3,300** | **1,716,000** |

These miscellaneous process loads are estimated consume about 2 million pounds of steam annually.

## 5.9 Boiler Plant Steam Use

The steam required for the boiler plant operations is supplied downstream from the boiler steam meters, and is therefore included in the steam model.

A summary of the steam requirements in the boiler plant is as follows.

- A. Dearator Heating of Feedwater
- B. Heating of Feedwater in Pre-Heaters 1, 2, & 3 (Prior to entering economizers)
- C. Fuel Oil Heating and Atomizing
- D. Soot Blowing

Table 5.9.1 summarizes the monthly mass balance for feedwater to the boilers, and steam and blowdown from the boilers. Feedwater is calculated by adding the average blowdown for this plant of 4% of feedwater into the boilers, to the monthly metered steam. The condensate return is a value determined by the boiler plant personnel, and the percentages are relative to the monthly feedwater totals.

The dearator steam demand is the theoretical percentage of total feedwater required to balance the mass and heat input to the dearators. The calculation used to determine this percentage is as follows, and the derivation of it can be found in Attachment 8.5, ECO S-4. The make-up percentage is the residual of the feedwater required to meet the site's steam demand.

Fort Detrick
1994 Boiler Mass Balance
Table 5.9.1

| Month | From Boilers | | | To Boilers | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Metered Steam (mlbs) | Boiler Blowdown (%) | Boiler Blowdown (mlbs) | Boiler Feedwater (mlbs) | Condensate Return (%) | Condensate Return (mlbs) | Make-Up Water (%) | Make-Up Water (mlbs) | Dearator Steam (%) | Dearator Steam (mlbs) |
| January | 91,468 | 4% | 3,811 | 95,279 | 34.5% | 32,871 | 54.9% | 52,261 | 10.7% | 10,147 |
| February | 73,302 | 4% | 3,054 | 76,356 | 32.5% | 24,816 | 56.7% | 43,256 | 10.8% | 8,285 |
| March | 72,571 | 4% | 3,024 | 75,595 | 32.2% | 24,342 | 57.0% | 43,104 | 10.8% | 8,149 |
| April | 60,387 | 4% | 2,516 | 62,903 | 38.2% | 24,029 | 51.5% | 32,408 | 10.3% | 6,466 |
| May | 56,888 | 4% | 2,370 | 59,258 | 44.2% | 26,192 | 46.1% | 27,318 | 9.7% | 5,748 |
| June | 40,090 | 4% | 1,670 | 41,760 | 36.6% | 15,284 | 53.0% | 22,116 | 10.4% | 4,360 |
| July | 39,926 | 4% | 1,664 | 41,590 | 34.2% | 14,224 | 55.1% | 22,924 | 10.7% | 4,442 |
| August | 44,452 | 4% | 1,852 | 46,304 | 36.6% | 16,947 | 53.0% | 24,523 | 10.4% | 4,834 |
| September | 44,099 | 4% | 1,837 | 45,936 | 38.2% | 17,548 | 51.5% | 23,666 | 10.3% | 4,722 |
| October | 53,362 | 4% | 2,223 | 55,585 | 39.3% | 21,845 | 50.5% | 28,071 | 10.2% | 5,670 |
| November | 52,550 | 4% | 2,190 | 54,740 | 40.4% | 22,115 | 49.5% | 27,096 | 10.1% | 5,529 |
| December | 62,302 | 4% | 2,596 | 64,898 | 44.0% | 28,555 | 46.2% | 29,983 | 9.8% | 6,360 |
| Ave. | 57,616 | 4% | 2,401 | 60,017 | 37.3% | 22,397 | 52.3% | 31,394 | 10.4% | 6,226 |
| Totals | 691,397 | N/A | 28,808 | 720,205 | N/A | 268,768 | N/A | 376,726 | N/A | 74,712 |

Notes:

A) Condenste return is assumed to be at 165 degree F (average), and it is listed based on Boiler Log data for month.

B) Water in a plate and frame exchanger is used to heat make-up to an average temperature of 60 degree F.

C) Boiler blowdown percentage included both continuous upper drum, and periodic lower drum totals.

Dearator Steam (% of feedwater)

$$\frac{lb}{hr}(S) = 100\ X\ \frac{\left(\left(\frac{btu}{lb}(F) - \frac{btu}{lb}(M)\right) - \left(\frac{lb}{hr}(C)\ X\left(\frac{btu}{lb}(C) - \frac{btu}{lb}(M)\right)\right)\right)}{\left(\frac{btu}{lb}(S) - \frac{btu}{lb}(M)\right)}$$

Make-up Water (% of feedwater)

$$\frac{lb}{hr}(M) = 100\ X\left(1 - \frac{lb}{hr}(C) - \frac{lb}{hr}(S)\right)$$

| | | |
|---|---|---|
| S | = | Deaerator Steam |
| F | = | Feedwater |
| C | = | Condensate Return |
| M | = | Make-up Water |

Table 5.9.2 summarizes the steam consumed by the boiler plant during 1994. Steam fueled by No. 6 fuel oil was estimated based on the gallons of oil burned during the month, and the combined efficiency of all five boilers on No. 6 fuel oil. This efficiency is determined later in Section 5.12 of this report. The calculation for estimating the steam fueled by No. 6 oil is shown below:

$$mlbs\ (S) = gallons\ (Fuel\ oil)\ X\ 149{,}600\ \frac{btu}{gal}\ X\ oil\ eff. \div \left(1{,}003\ \frac{btu}{lb}\ X\ 1{,}000\ \frac{lb}{mlb}\right)$$

Feedwater heating combines the steam required for the dearator, minus the amount blowdown flashed, and sent to the dearator, with the steam required to pre-heat feedwater prior to entering the economizers on Boilers 1, 2, and 3. The general equation is as follows:

$$mlbs(S) = \frac{(mlb(DR) - mlb(FB)) + (mlb(F)\ X\ .83(\%\ of\ boiler\ 1,2,3/yr)\ X\ 30\frac{btu}{lb}(P)}{1,023\ \frac{btu}{lb}\ (PSC)}$$

| | | |
|---|---|---|
| S | = | Steam for Feedwater Heating |
| DR | = | Dearator Demand |
| FB | = | Flashed Blowdown Recovered |
| F | = | Feedwater Total |
| P | = | Pre-heater Temperature Rise |
| PSC | = | Pre-heater steam to condensate |

The remaining plant uses include No. 6 fuel oil storage and heating, steam used for atomizing fuel oil during firing, and the steam required for soot blowing (cleaning) the boilers. The percentages listed in the notes for Table 5.9.2 were taken from the Results for the Nationwide Oil-Versus-Gas Boiler test program that appeared in Energy Engineering, Vol. 91, No. 4, 1994.

These percentages are applied against the steam fueled by oil value for estimating the additional used by the plant. The total plant usage is then calculated by adding up all the consumptions. The percentages of steam out of the boilers consumed by the plant is then calculated. The average monthly demand by the plant is 13.8%, or 7,900 mlb/month (10,800 lb/hr).

Fort Detrick
1994 Boiler Plant Steam Consumption
Table 5.9.2

| Month | Metered Steam (mlbs) | Steam Fueled by Oil (mlbs) | Boiler Plant Steam Consumption (See Note 1) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feedwater Heating (mlbs) | Preheating at Economizers (mlbs) | Fuel Oil Storage (mlbs) | Fuel Oil Heating (mlbs) | Fuel Oil Atomiz. (mlbs) | Soot Blowing (mlbs) | Total Plant Usage (mlbs) | Total Plant Usage (%) Output |
| January | 91,468 | 80,414 | 9,652 | 2,315 | 549 | 482 | 563 | 322 | 13,883 | 15.2% |
| February | 73,302 | 47,531 | 7,888 | 1,856 | 440 | 285 | 333 | 190 | 10,991 | 15.0% |
| March | 72,571 | 0 | 7,756 | 1,837 | 435 | 0 | 0 | 0 | 10,029 | 13.8% |
| April | 60,387 | 0 | 6,139 | 1,529 | 362 | 0 | 0 | 0 | 8,030 | 13.3% |
| May | 56,888 | 0 | 5,440 | 1,440 | 0 | 0 | 0 | 0 | 6,880 | 12.1% |
| June | 40,090 | 60 | 4,143 | 1,015 | 120 | 0.4 | 0.4 | 0.2 | 5,279 | 13.2% |
| July | 39,926 | 0 | 4,226 | 1,011 | 0 | 0 | 0 | 0 | 5,236 | 13.1% |
| August | 44,452 | 0 | 4,593 | 1,125 | 0 | 0 | 0 | 0 | 5,719 | 12.9% |
| September | 44,099 | 0 | 4,483 | 1,116 | 0 | 0 | 0 | 0 | 5,600 | 12.7% |
| October | 53,362 | 5,115 | 5,381 | 1,351 | 0 | 31 | 36 | 20 | 6,818 | 12.8% |
| November | 52,550 | 0 | 5,244 | 1,330 | 315 | 0 | 0 | 0 | 6,890 | 13.1% |
| December | 62,302 | 56,116 | 6,023 | 1,577 | 374 | 337 | 393 | 224 | 8,927 | 14.3% |
| Ave. | 57,616 | 15,770 | 5,914 | 1,458 | 216 | 95 | 110 | 63 | 7,857 | 13.6% |
| Totals | 691,397 | 189,236 | 70,967 | 17,502 | 2,596 | 1,135 | 1325 | 757 | 94,282 | 13.6% |

Notes:

1) Space heating for the Boiler Plant is included in the site steam use model.

2) The following assumptions were made to determine information in Table 5.9.2.

A) 4% of feedwater make–up goes to boiler blowdown.

B) 13% of boiler blowdown is flashed, for use in the dearators.

C) 0.6% steam produced by fuel oil is for outdoor storage.

D) 0.6% steam produced by fuel oil is for boiler pre–heating.

E) 0.7% steam produced by fuel oil is for boiler atomization.

F) 0.4% steam produced by fuel oil is for boiler soot blowing.

Source: Energy Engineering Vol. 91, No. 4 1994. "Results from the Nationwide Oil–Versus–Gas Boiler Test Program," Herbert M. Eckerlin, PhD.,P.E.

## 5.10 Steam Distribution Losses

The losses associated with the site's steam distribution are difficult to estimate. The effort to walkdown the entire system for detailing the condition of piping and insulation is beyond the scope of this project. Visual and physical accessibility to all the piping is questionable. A separate study would be required to complete. However, the majority of the distribution piping was walked down, and it was also reviewed on existing drawings to the degree required to develop the total piping estimate shown previously in Section 3.3, Table 3.3.1.

Entech has utilized two methods for estimating distribution losses. The first method is to estimate the amount of heat loss from piping lengths in Table 3.3.1, using average estimated heat transfer coefficients, pipe sizes, and insulation thickness, and the seasonal temperature difference with the outdoor air or ground. The second method is to subtract the steam use previously identified in the previous steam usage models, from the total measured steam production. The residual is considered losses. These losses include heat loss from the steam piping, steam leaks, and the overheating of buildings in the intermediate months.

The results associated with the first methods is summarized in Table 5.10.1

**Estimated Distribution Losses - Method 1**
**Table 5.10.1**

| Period | Total (lbs/month) | Avg. (lbs/hr) | Total (lbs/yr) |
|---|---|---|---|
| Winter | 7,300,000 | 10,000 | 29,200,000 |
| Summer | 6,611,000 | 9,000 | 26,444,000 |
| Spring/Fall | 6,956,000 | 9,500 | 27,824,000 |
| **Total** | **N/A** | **N/A** | **83,468,000** |

The backup for this table is shown in Table 5.10.2 The steam distribution losses using the method estimates the range to be 9,000 - 10,000 lb/hr.

As mentioned, a second method was used by Entech to balance the site steam use model, which is summarized in Section 5.11. The residual averages for these periods are shown in Table 5.10.3

**Estimated Residual Losses - Method 2**
**Table 5.10.3**

| Period | Total (lbs/month) | Avg. (lbs/hr) | Total (lbs/yr) |
|---|---|---|---|
| Winter | 7,694,688 | 10,500 | 30,778,751 |
| Summer | 9,054,312 | 12,400 | 36,217,249 |
| Spring/Fall | 11,376,825 | 15,600 | 45,507,299 |
| **Total** | **N/A** | **N/A** | **112,503,299** |

The estimates for the piping distribution losses, in Table 5.10.1, along with residual losses shown in Table 5.10.3 are both rough estimates but within the

accuracy and intent of this report. The purpose for the estimates made in Table 5.10.1 are for evaluating ECOs related to piping insulation, line pressure reduction, etc.

Table 5.10.3 reflects what Entech feels is the overall losses associated with the entire system including steam leaks, over heating of buildings, variations in site utilization practices, etc. The information in the table will be used for evaluating the ECO for improving condensate return, etc.

Comments about the overall steam use model will follow in Section 5.11, following the backup information for the piping distribution estimate, Table 5.10.2.

## Ft. Detrick
## Details for Estimated Pipe Losses – Method 1
### Table 5.10.2

Summer Losses

| Period | % Pipe | Est. Total Ft. | Ave. U | Ave. O.D. | Ave. Thick | Total Area | Pipe Temp. | Amb.Temp | Btu's Lost | lb/hr | mlb/month |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Underground (Summer) | 10% | 4,300 | 0.2 | 8.75 | 0 | 9,850 | 330 | 55 | 595,939 | 662 | 483 |
| Under Tunnel (Summer) | 55% | 23,650 | 0.3 | 8.75 | 1.5 | 72,751 | 330 | 65 | 6,362,070 | 7,069 | 5,161 |
| Aboveground (Summer) | 35% | 15,050 | 0.08 | 8.75 | 2.5 | 54,176 | 330 | 80 | 1,191,877 | 1,324 | 967 |
| Totals | | 43,000 | | | | 136,777 | | | 8,149,886 | 9,055 | 6,611 |

Winter Losses

| Period | % Pipe | Est. Total Ft. | Ave. U | Ave. O.D. | Ave. Thick | Total Area | Pipe Temp. | Amb.Temp | Btu's Lost | lb/hr | mlb/month |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Underground (Winter) | 10% | 4,300 | 0.2 | 8.75 | 0 | 9,850 | 330 | 50 | 606,774 | 674 | 492 |
| Under Tunnel (Winter) | 55% | 23,650 | 0.3 | 8.75 | 1.5 | 72,751 | 330 | 40 | 6,962,266 | 7,736 | 5,648 |
| Aboveground (Winter) | 35% | 15,050 | 0.08 | 8.75 | 2.5 | 54,176 | 330 | 30 | 1,430,253 | 1,589 | 1,160 |
| Totals | | 43,000 | | | | 136,777 | | | 8,999,292 | 9,999 | 7,300 |

Notes:

1) The average pipe size of 8 inches was assumed for all the steam piping. The average insulation for the steam piping was assumed to be a maximum of 2.5 inches.

2) The U–value for the aboveground piping assumes that all of this piping is properly insulated.

3) The U–value for the underground and undertunnel piping are an average that takes into account uninsulated piping, poor conditioned insulation, surrounding medium (air verus earth), etc.

4) Steam leaks and seasonal over–heating are not included in these totals.

5) The spring/fall values in Table 5.10.1 are averages of the summer and winter estimates.

## 5.11 Steam Use Model

Entech's steam use model summarizes information from Sections 5.2 through 5.10. The information included here pertains to the individual buildings uses, and for the site uses by month.

Table 5.11.1 reflects the building usage totals associated with Sections 5.2 through 5.8 only. The impact of each building is also shown as the "Steam Ratio", and relates to the portion of the building totals only. Most notably the Steam Sterilization Plant (Building 375), the Cancer Research Center (Building 560), and the Army's USAMARIID Annex (Building 1425) constitute the majority of building steam usage (36% to total).

Table 5.11.2 summarizes the impact of each type of use, (Sections 5.2 through 5.10) by month for 1994. As stated previously in Section 5.10 the losses predicted here are the residual totals required to balance the usage load for the month. This information is shown graphically in Figure 5.11.3.

When reviewing these results it becomes evident that the losses are not as consistent as they were estimated in Table 5.10.1. The effect of combining these values within the level of accuracy for this report explains some of these discrepancies. Additionally, effects of under or over heating spaces during the heating season also impacts this, especially the intermediate months tendency for over heating.

# FORT DETRICK
## FREDERICK, MARYLAND
## Table 5.11.1
## ESTIMATE OF TOTAL STEAM USE IN POUNDS OF STEAM PER YEAR

| Bldg. No. | Building Name | Building Use | Space Heating | Reheats | Humidification | Dom. Hot Water | Autoclaves/Cage Washers | Decon/Process | TOTAL (Lb/Yr) | Stm. Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| S-10 | Signal Service | Office | 437,000 | | | | | | 437,000 | 0.00 |
| S-11 | Thrift Shop | Store | 285,000 | | | | | | 285,000 | 0.00 |
| S-12 | Signal Service | Empty? | 95,000 | | | | | | 95,000 | 0.00 |
| S-100 | Outside Electric Shop | Warehouse/Shop/Office | 222,000 | | | | | | 222,000 | 0.00 |
| S-101 | Sewage Pump | | 35,000 | | | | | | 35,000 | 0.00 |
| S-122 | Rodent/Pest Control | Storage | 49,000 | | | | | | 49,000 | 0.00 |
| 190 | BOILER PLANT | | 1,064,000 | | | | | | 1,064,000 | 0.00 |
| S-199 | FE Mnt. Shop | Wharehouse/Shop | 536,000 | | | | | | 536,000 | 0.00 |
| 200 | | Equipment Shed | 53,000 | | | | | | 53,000 | 0.00 |
| S-201 | Engineering Offices | Offices | 1,602,000 | | | | | | 1,602,000 | 0.00 |
| T-239 | Cancer Research Center | Warehouse | 760,000 | | | | | | 760,000 | 0.00 |
| S-243 | Fe Sths | Warehouse/Shop | 501,000 | | | | | | 501,000 | 0.00 |
| S-244 | Cancer Research Center | Office | 484,000 | | | | | | 484,000 | 0.00 |
| T-248 | Cancer Research Center | Warehouse | 699,000 | | | | | | 699,000 | 0.00 |
| T-249 | Cancer Research Center | Warehouse | 699,000 | | | | | | 699,000 | 0.00 |
| S-261 | Radiology | Labratory | 427,000 | | | | | | 427,000 | 0.00 |
| S-262 | Gen. Storehouse | Warehouse | 222,000 | | | | | | 222,000 | 0.00 |
| S-263 | Fe Mnt Shop | Mech Shops/Storehous | 1,056,000 | | | | | | 1,056,000 | 0.00 |
| S-312 | CRC - Fermentation Production Facility | | 30,000 | | | | | | 30,000 | 0.00 |
| S-313 | CRC - Fermentation Production Facility | | 393,000 | | | 4,000 | 133,000 | | 530,000 | 0.00 |
| 314 | Cancer Research Center | Warehouse/Shop | 168,000 | | | | | | 168,000 | 0.00 |
| S-318 | | Warehouse | 251,000 | | | | | | 251,000 | 0.00 |
| S-319 | | Warehouse | 251,000 | | | | | | 251,000 | 0.00 |
| S-321 | Cancer Research Center | Office | 380,000 | | | 2,000 | | | 382,000 | 0.00 |
| S-322 | Cancer Research Center | Office | 380,000 | | | 2,000 | | | 382,000 | 0.00 |
| S-323 | Cancer Research Center | Warehouse | 146,000 | | | | | | 146,000 | 0.00 |
| S-324 | NCI-FCRF Central Supply & Trans | Warehouse | 332,000 | | | | | | 332,000 | 0.00 |
| S-325 | Cancer Research Center | Labratory | 2,107,000 | 1,602,000 | | 23,000 | 533,000 | 62,000 | 4,327,000 | 0.01 |
| 326 | USDA | Storage | 15,000 | | | | | | 15,000 | 0.00 |
| S-347 | Cancer Research Center | Chemical Storage | 152,000 | | | | | | 152,000 | 0.00 |
| 349 | Cancer Research Center | Office | 304,000 | | | 2,000 | | | 306,000 | 0.00 |
| S-350 | Cancer Research Center | Office/Maintenance | 883,000 | | | 108,000 | | | 991,000 | 0.00 |
| S-361 | Cancer Research Center | Maintenance Shop | 866,000 | | | 104,000 | | | 970,000 | 0.00 |
| T-362 | Cancer Research Center | Office | 952,000 | | | 5,000 | | | 957,000 | 0.00 |
| 374 | USDA | Lab | 3,146,000 | 2,304,000 | | 33,000 | 667,000 | 10,000 | 6,160,000 | 0.01 |
| 375 | Steam Sterilization Plant | Shop | 2,014,000 | | | | 267,000 | 45,388,000 | 47,669,000 | 0.10 |
| 376 | Cancer Research Center | Labratory | 4,162,000 | 3,919,000 | 1872000 | 569,000 | 3,058,000 | | 13,580,000 | 0.03 |
| 393 | Incinerator | Incinerator | 1,299,000 | | | | | | 1,299,000 | 0.00 |
| S-426 | CRC-Safety Protective Services | Offices/Med | 603,000 | | | 4,000 | 133,000 | | 740,000 | 0.00 |
| 427 | Cancer Research Center | Office | 532,000 | | | 3,000 | | | 535,000 | 0.00 |
| 428 | Cancer Research Center | Office | 656,000 | | | 4,000 | | | 660,000 | 0.00 |

## FORT DETRICK
### FREDERICK, MARYLAND
### Table 5.11.1
### ESTIMATE OF TOTAL STEAM USE IN POUNDS OF STEAM PER YEAR

| Bldg. No. | Building Name | Building Use | Space Heating | Reheats | Humidification | Dom. Hot Water | Autoclaves/Cage Washers | Decon/Process | TOTAL (Lb/Yr) | Stm. Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| 429 | Cancer Research Center | Lab | 1,135,000 | 801,000 | 374000 | 116,000 | 431,000 | | 2,857,000 | 0.01 |
| 430 | Cancer Research Center | Office | 342,000 | | | 3,000 | | | 345,000 | 0.00 |
| 431 | Cancer Research Center | Lab | 2,052,000 | 1,502,000 | | 22,000 | 800,000 | 62,000 | 4,438,000 | 0.01 |
| S-432 | Cancer Research Center | Lab | 2,859,000 | 2,692,000 | | 39,000 | 133,000 | | 5,723,000 | 0.01 |
| S-433 | Cancer Research Center | Lab | 1,028,000 | | | 11,000 | 267,000 | | 1,306,000 | 0.00 |
| S-434 | CRC - Fermentation | Offices/Lab | 1,398,000 | | | 7,000 | 267,000 | | 1,672,000 | 0.00 |
| S-459 | Cancer Research Center | Warehouse/Shop | 969,000 | | | 5,000 | | | 974,000 | 0.00 |
| 469 | Cancer Research Center | Labratory | 9,591,000 | 7,023,000 | | 102,000 | 1,067,000 | 156,000 | 17,939,000 | 0.04 |
| 472 | Cancer Research Center | Labratory | 1,111,000 | | | 12,000 | 133,000 | | 1,256,000 | 0.00 |
| T-501 | Education/Library | Office | 770,000 | | | | | | 770,000 | 0.00 |
| S-504 | USAMRDC | Office | 993,000 | | | | | | 993,000 | 0.00 |
| S-505 | HQ USAMRDC | Office | 395,000 | | | | | | 395,000 | 0.00 |
| S-521 | Adm Gen Purp | Office | 1,165,000 | | | | | | 1,165,000 | 0.00 |
| S-522 | Cancer Research Center | Labratory | 2,305,000 | 1,628,000 | 778000 | 236,000 | 862,000 | | 5,809,000 | 0.01 |
| S-524 | USAMBRDL Admin | Office | 906,000 | | | | | | 906,000 | 0.00 |
| S-525 | Adm Gen Purp | Office | 659,000 | | | | | | 659,000 | 0.00 |
| 538 | Cancer Research Center | Labratory | 10,976,000 | 8,037,000 | 3830000 | 350,000 | 925,000 | | 24,118,000 | 0.05 |
| 539 | CRC-Leroy D. Fothergill Lab | Lab | 18,175,000 | 13,821,000 | 6581000 | 2,007,000 | 2,885,000 | | 43,469,000 | 0.09 |
| 549 | Cancer Research Center | Library | 1,330,000 | | | 8,000 | | | 1,338,000 | 0.00 |
| 550 | Cancer Research Center | Labratory | 3,419,000 | 2,504,000 | 1195000 | 364,000 | 596,000 | | 8,078,000 | 0.02 |
| 560 | Cancer Research Center | Labratory | 22,605,000 | 21,283,000 | | 309,000 | 4,000,000 | | 48,197,000 | 0.10 |
| 562 | Cancer Research Center | Labratory | 1,995,000 | 1,878,000 | | 27,000 | | | 3,900,000 | 0.01 |
| 567 | Cancer Research Center | Lab | 4,388,000 | 4,131,000 | 1973000 | 600,000 | 729,000 | 62,000 | 11,883,000 | 0.02 |
| 568 | Biomedical R&D lab | Lab | 6,556,000 | 6,172,000 | | 90,000 | | 25,000 | 12,843,000 | 0.03 |
| 571 | CRC-ANIMAL BUILDINGS | Labratory | 4,747,000 | 4,469,000 | 2131000 | 649,000 | 996,000 | 62,000 | 13,054,000 | 0.03 |
| 576 | CRC-Biological Response Modifier | Office | 125,000 | | | 1,000 | | | 126,000 | 0.00 |
| T-611 | William Strough Auditorium | Auditorium w/stage | 889,000 | | | | | | 889,000 | 0.00 |
| S-660 | Visiting Officers Quarters | Residence | 1,159,000 | | | 6,000 | | | 1,165,000 | 0.00 |
| T-701 | | Office | 203,000 | | | | | | 203,000 | 0.00 |
| T-703 | Fire Station | | 233,000 | | | | | | 233,000 | 0.00 |
| T-713 | Post Exchange | Post Exchange | 973,000 | | | | | | 973,000 | 0.00 |
| T-715 | Judge Advocate/Legal Assist DVQ | Office | 243,000 | | | | | | 243,000 | 0.00 |
| T-718 | Community Club | Community Club | 997,000 | | | 5,000 | | | 1,002,000 | 0.00 |
| T-722 | Adm. Gen Purp. | Office | 973,000 | | | | | | 973,000 | 0.00 |
| T-817 | ASAMRAA | Office | 1,054,000 | | | | | | 1,054,000 | 0.00 |
| 810 | Administration | Office | 1,949,000 | | | | | | 1,949,000 | 0.00 |
| T-818 | Administration | | 203,000 | | | | | | 203,000 | 0.00 |
| T-819 | ASAMRAA | Office | 142,000 | | | | | | 142,000 | 0.00 |
| T-820 | ASAMRAA | Office | 729,000 | | | | | | 729,000 | 0.00 |
| T-823 | Medical Logistics | Office | 213,000 | | | | | | 213,000 | 0.00 |
| T-824 | Medical Logistics | Office | 213,000 | | | | | | 213,000 | 0.00 |

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.11.1**
**ESTIMATE OF TOTAL STEAM USE IN POUNDS OF STEAM PER YEAR**

| Bldg. No. | Building Name | Building Use | Space Heating | Reheats | Humidification | Dom. Hot Water | Autoclaves/Cage Washers | Decon/Process | TOTAL (Lb/Yr) | Stm. Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| T-830 | Training Center | Office | 1,235,000 | | | | | | 1,235,000 | 0.00 |
| T-833 | Navy | Office | 1,103,000 | | | | | | 1,103,000 | 0.00 |
| T-834 | Navy | Office | 82,000 | | | | | | 82,000 | 0.00 |
| T-835 | | Office | 263,000 | | | | | | 263,000 | 0.00 |
| T-838 | Field House | Field House/Gym | 3,224,000 | | | 3,855,000 | | | 7,079,000 | 0.01 |
| S-839 | Fitness Center | Gym | 697,000 | | | 1,525,000 | | | 2,222,000 | 0.00 |
| T-901 | Gen. Store House | Warehouse | 1,456,000 | | | | | | 1,456,000 | 0.00 |
| T-902 | Motor Pool | Office | 466,000 | | | | | | 466,000 | 0.00 |
| T-903 | Motor Pool | Office | 203,000 | | | | | | 203,000 | 0.00 |
| T-904 | Motor Pool | Office | 203,000 | | | | | | 203,000 | 0.00 |
| T-914 | PM Adm | Office | 375,000 | | | | | | 375,000 | 0.00 |
| 915 | Bowling Center | Bowling/Office | 823,000 | | 302000 | | | | 1,125,000 | 0.00 |
| T-921 | Car Wash/Auto Shop | Shop | 495,000 | | | 52,000 | | | 547,000 | 0.00 |
| T-925 | Religious Education | Training/Education | 213,000 | | | | | | 213,000 | 0.00 |
| 949 | YOUTH CENTER | Youth Center | 296,000 | | | | | | 296,000 | 0.00 |
| 1021 | Cancer Research Center | Admin/Food Storage | 712,000 | | | | 62,000 | | 774,000 | 0.00 |
| 1022-1049 | CRC-ANIMAL BUILDINGS | Animal Storage | 5,927,000 | 4,507,000 | 2146000 | 654,000 | 3,867,000 | | 17,101,000 | 0.04 |
| 1040 | CRC-ANIMAL BUILDINGS | Maintenance | 228,000 | | | | | | 228,000 | 0.00 |
| 1050 | Cancer Research Center | Warehouse/Offices | 1,773,000 | | | | | | 1,773,000 | 0.00 |
| 1054 | Medical Advance Tech Mgmnt | Office/Warehouse | 3,280,000 | | | 19,000 | | | 3,299,000 | 0.01 |
| 1301 | USDA | Labs/Offices | 6,569,000 | 4,995,000 | | 73,000 | 1,600,000 | 56,000 | 13,293,000 | 0.03 |
| 1302 | USDA | Labs/Offices | 1,449,000 | 1,102,000 | | 16,000 | | | 2,567,000 | 0.01 |
| 1303 | USDA | Greenhouse | 773,000 | | | | | | 773,000 | 0.00 |
| 1304 | USDA | Greenhouse | 773,000 | | | | | | 773,000 | 0.00 |
| 1305 | USDA | Greenhouse | 773,000 | | | | | | 773,000 | 0.00 |
| 1306 | USDA | Greenhouse | 773,000 | | | | | | 773,000 | 0.00 |
| 1412 | USAMRIID ANNEX | Lab | 9,308,000 | 8,764,000 | 4176000 | 127,000 | 1,333,000 | 704,000 | 24,412,000 | 0.05 |
| 1414 | USAMRIID ANNEX | Warehouse | 152,000 | | | | | | 152,000 | 0.00 |
| 1422 | DATA PROCESSING | Office | 638,000 | | | | | | 638,000 | 0.00 |
| 1425 | USAMRIID ANNEX | Lab | 29,799,000 | 28,056,000 | 13363000 | 407,000 | 5,200,000 | | 76,825,000 | 0.16 |
| 1430 | ENLISTED BARRACKS | Residence | 3,386,000 | | | 681,000 | | 482,000 | 4,549,000 | 0.01 |
| 1520 | Commisary | Commisary | 3,809,000 | | | | | | 3,809,000 | 0.01 |
| TOTALS | | | 222,671,000 | 131,190,000 | 38,721,000 | 13,241,000 | 30,944,000 | 47,069,000 | 483,836,000 | |

**FORT DETRICK**
**FREDERICK, MARYLAND**
**Table 5.11.2**
**ESTIMATE OF TOTAL STEAM USE IN POUNDS OF STEAM PER YEAR**

| 1994 | Average HDD | Space Heating | Reheats | Humidification | Dom. Hot Water | Autoclaves/ Cage Washers | Decontamination/ Other Process | Boiler Plant Steam Use | Losses | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 1,322 | 53,229,000 | 0 | 9,680,250 | 1,103,417 | 2,578,667 | 3,051,920 | 13,883,000 | 7,941,747 | 91,468,000 |
| Feb | 1,017 | 40,948,000 | 0 | 9,680,250 | 1,103,417 | 2,578,667 | 2,572,163 | 10,991,000 | 5,428,504 | 73,302,000 |
| Mar | 851 | 34,264,000 | 0 | 9,680,250 | 1,103,417 | 2,578,667 | 3,194,641 | 10,029,000 | 11,721,026 | 72,571,000 |
| Apr | 281 | 11,314,000 | 18,741,429 | 4,840,125 | 1,103,417 | 2,578,667 | 3,633,349 | 8,030,000 | 10,146,014 | 60,387,000 |
| May | 215 | 8,657,000 | 18,741,429 | 0 | 1,103,417 | 2,578,667 | 3,773,680 | 6,880,000 | 15,153,808 | 56,888,000 |
| Jun | 0 | 0 | 18,741,429 | 0 | 1,103,417 | 2,578,667 | 4,375,979 | 5,279,000 | 8,011,509 | 40,090,000 |
| Jul | 0 | 0 | 18,741,429 | 0 | 1,103,417 | 2,578,667 | 5,296,526 | 5,236,000 | 6,969,962 | 39,926,000 |
| Aug | 0 | 0 | 18,741,429 | 0 | 1,103,417 | 2,578,667 | 6,157,767 | 5,719,000 | 10,151,721 | 44,452,000 |
| Sep | 0 | 0 | 18,741,429 | 0 | 1,103,417 | 2,578,667 | 4,220,398 | 5,600,000 | 11,855,090 | 44,099,000 |
| Oct | 405 | 16,307,000 | 9,370,714 | 0 | 1,103,417 | 2,578,667 | 4,369,098 | 6,818,000 | 12,815,104 | 53,362,000 |
| Nov | 549 | 22,105,000 | 9,370,714 | 0 | 1,103,417 | 2,578,667 | 3,141,497 | 6,890,000 | 7,360,705 | 52,550,000 |
| Dec | 892 | 35,915,000 | 0 | 4,840,125 | 1,103,417 | 2,578,667 | 3,281,982 | 8,927,000 | 5,655,810 | 62,302,000 |
| TOTAL | 5,532 | 222,739,000 | 131,190,000 | 38,721,000 | 13,241,000 | 30,944,000 | 47,069,000 | 94,282,000 | 113,211,000 | 691,397,000 |

1. Heating Degree Days based on data collected at the Fort Detrick Boiler Plant.
2. 1993 data used for October, November, and December estimates of steam use for sewage decontamination.

## Estimated Total Steam Use
## In LBS of Steam per Year

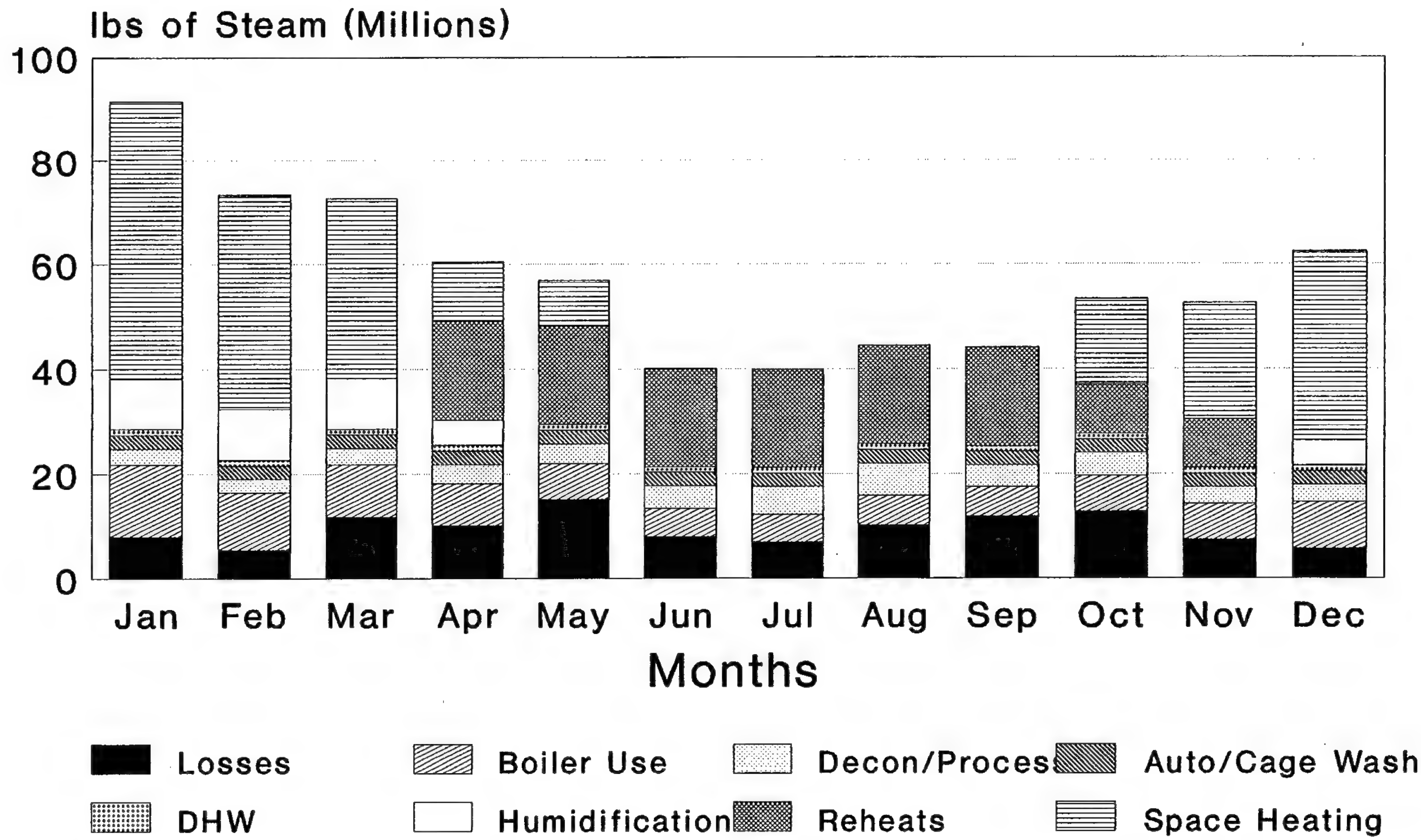


Figure 5.11.3

Table 5.11.4 and Figure 5.11.5 summarize of the different uses and their impact on the overall steam use at the site.

**1994 Steam Use Summary**
**Table 5.11.4**

| Use | Total (lbs/yr) | % of Total |
|---|---|---|
| Space Heating | 222,739,000 | 32.2% |
| Reheats | 131,190,000 | 19.0% |
| Humidification | 38,721,000 | 5.6% |
| Domestic Hot Water | 13,241,000 | 1.9% |
| Autoclaves/Cage Washers | 30,944,000 | 4.5% |
| Decontamination/Other Processes | 47,069,000 | 6.8% |
| Boiler Plant Use | 94,282,000 | 13.6% |
| Losses | 113,211,000 | 16.4% |
| **Totals** | **691,397,000** | **100.0%** |

Space heating, reheats, boiler plant and losses make up over 81% of the steam used at the Fort Detrick site. Focusing on these users will likely result in the best results during the ECO (Energy Conservation Opportunities) process of this study.

# 1994 Steam Use Summary

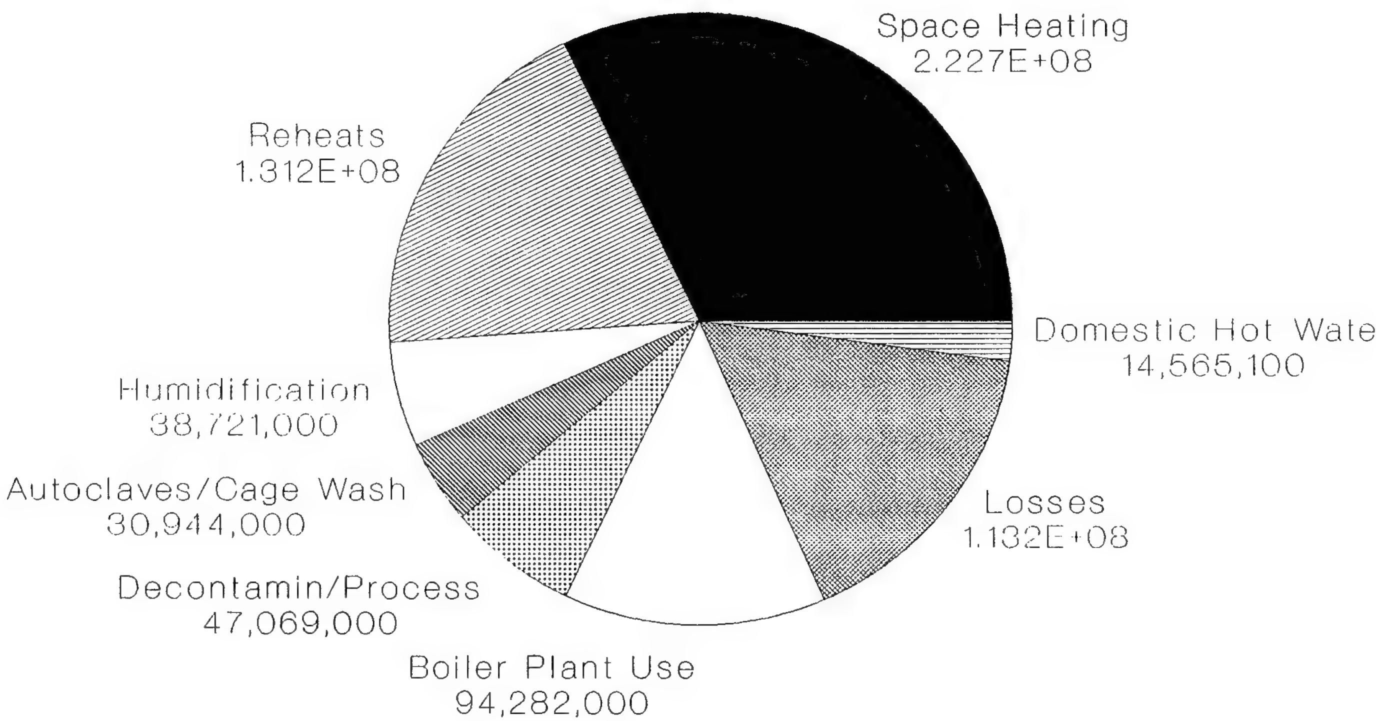


Figure 5.11.5

## 5.12 Fuel Use Model

The fuel use model reviews the fuel use and cost by the month to determine the total fuel costs and energy use for generating steam at the site including fuel used for banking. These totals are then broken down by use to determine the cost impact. The model also evaluates the total fuel burned (minus banking totals) relative to the individual boilers steam production. From this the model will determine the efficiencies for the boilers on fuel to steam for both fuels.

Table 5.12.1 is a summary of the gas and oil usage totals in volume (mcf and gallons) and heat content (mmBtu). The associated costs are then calculated based on incremental rates noted in Section 4.0. The total estimated cost of fuel to operate the boilers in 1994 is approximately $3,009,000. This figure will be our basis for savings associated with some of the ECOs. Figure 5.12.2 is a graphical summary of Table 5.12.1

**Fort Detrick**
**Gas and Oil Usage/Costs**
**1994 by Month**
**Table 5.12.1**

| Month | Log mcf | Gas Cost ($) | % Total Cost ($) | Gas mmBtu | % Total mmBtu | Log gal | Oil Cost ($) | % Total Cost ($) | Oil mmBtu | % Total mmBtu | Total Cost ($) | Total mmBtu |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| January | 18,061 | $63,755 | 17.8% | 18,603 | 15.1% | 699,269 | $293,693 | 82.2% | 104,611 | 84.9% | $357,448 | 123,213 |
| February | 36,428 | $128,592 | 42.6% | 37,521 | 37.8% | 413,326 | $173,597 | 57.4% | 61,834 | 62.2% | $302,189 | 99,355 |
| March | 91,325 | $322,379 | 100.0% | 94,065 | 100.0% | 0 | $0 | 0.0% | 0 | 0.0% | $322,379 | 94,065 |
| April | 76,152 | $268,815 | 100.0% | 78,436 | 100.0% | 0 | $0 | 0.0% | 0 | 0.0% | $268,815 | 78,436 |
| May | 72,092 | $254,484 | 100.0% | 74,255 | 100.0% | 0 | $0 | 0.0% | 0 | 0.0% | $254,484 | 74,255 |
| June | 50,733 | $179,089 | 99.9% | 52,255 | 99.9% | 524 | $220 | 0.1% | 78 | 0.1% | $179,309 | 52,334 |
| July | 52,624 | $185,763 | 100.0% | 54,203 | 100.0% | 0 | $0 | 0.0% | 0 | 0.0% | $185,763 | 54,203 |
| August | 58,449 | $206,324 | 100.0% | 60,202 | 100.0% | 0 | $0 | 0.0% | 0 | 0.0% | $206,324 | 60,202 |
| September | 56,463 | $199,314 | 100.0% | 58,157 | 100.0% | 0 | $0 | 0.0% | 0 | 0.0% | $199,314 | 58,157 |
| October | 61,444 | $216,899 | 92.1% | 63,288 | 90.5% | 44,476 | $18,680 | 7.9% | 6,654 | 9.5% | $235,579 | 69,941 |
| November | 68,467 | $241,689 | 100.0% | 70,521 | 100.0% | 0 | $0 | 0.0% | 0 | 0.0% | $241,689 | 70,521 |
| December | 14,298 | $50,473 | 19.8% | 14,727 | 16.8% | 487,976 | $204,950 | 80.2% | 73,001 | 83.2% | $255,423 | 87,729 |
| Ave. | 54,711 | $193,131 | 77.0% | 56,353 | 73.3% | 137,131 | $57,595 | 23.0% | 20,515 | 26.7% | $250,726 | 76,868 |
| **Totals** | 656,537 | $2,317,575 | N/A | 676,233 | N/A | 1,645,571 | $691,140 | N/A | 246,177 | N/A | $3,008,715 | 922,410 |

# 1994 Fuel Usage/Cost Summary
## Gas & Oil

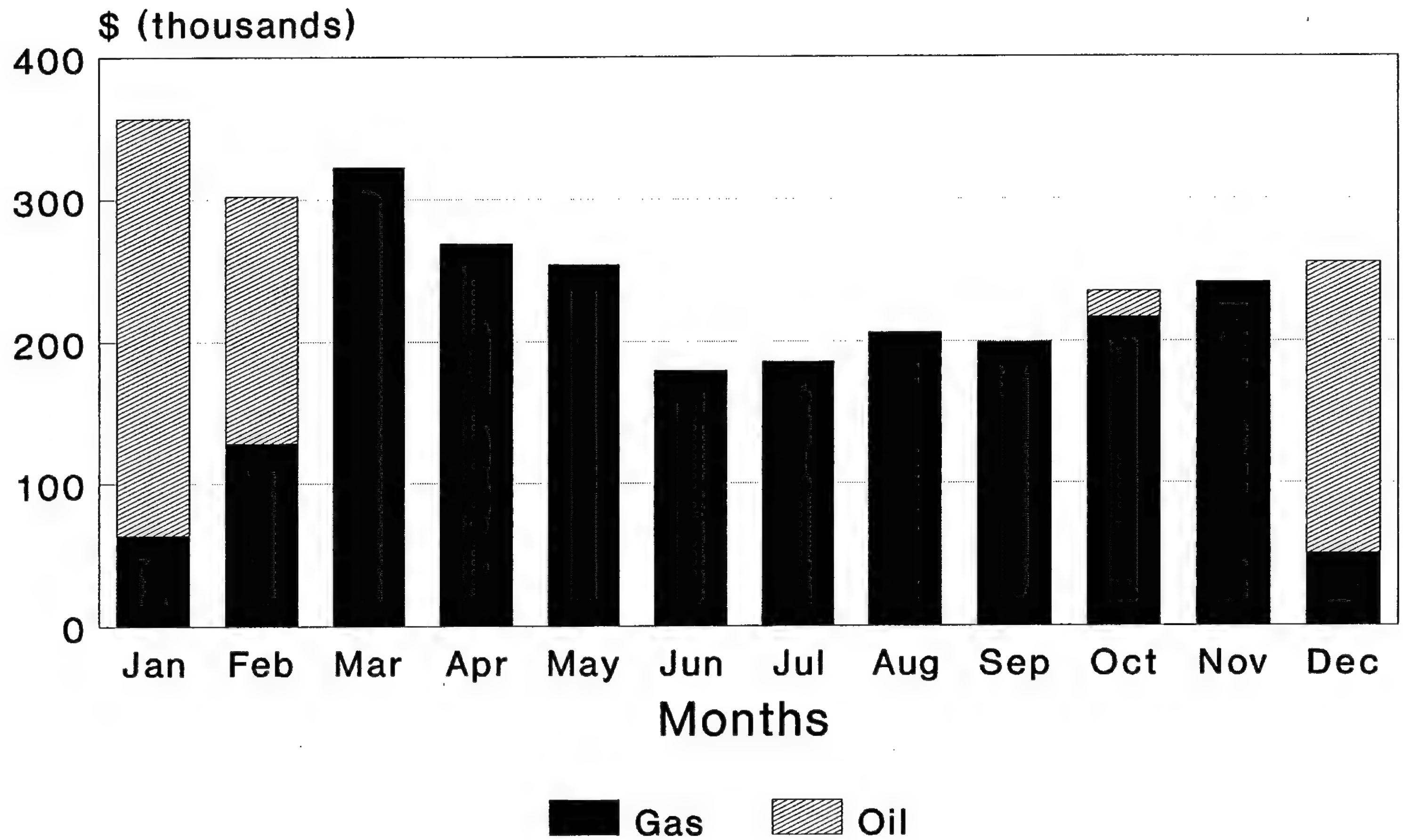


Figure 5.12.2

Table 5.12.3 and Figure 5.12.4 portions this total to the uses defined in Section 5.11. These valves are the fuel costs associated with the percentage totals for the steam uses.

**1994 Fuel Costs/Site Usage Costs**
**Table 5.12.3**

| | % Steam Use | $ Cost |
|---|---|---|
| Space Heating | 32.2% | $968,900 |
| Reheats | 19.0% | $571,700 |
| Humidification | 5.6% | $168,500 |
| Domestic Hot Water | 1.9% | $57,200 |
| Autoclaves/Cage Washers | 4.5% | $135,400 |
| Decontamination/Other Processes | 6.8% | $204,600 |
| Boiler Plant Use | 13.6% | $409,200 |
| Losses | 16.4% | $493,500 |
| **Total** | **100.0%** | **$3,009,000** |

# 1994 Fuel Costs/Site Usage Cost

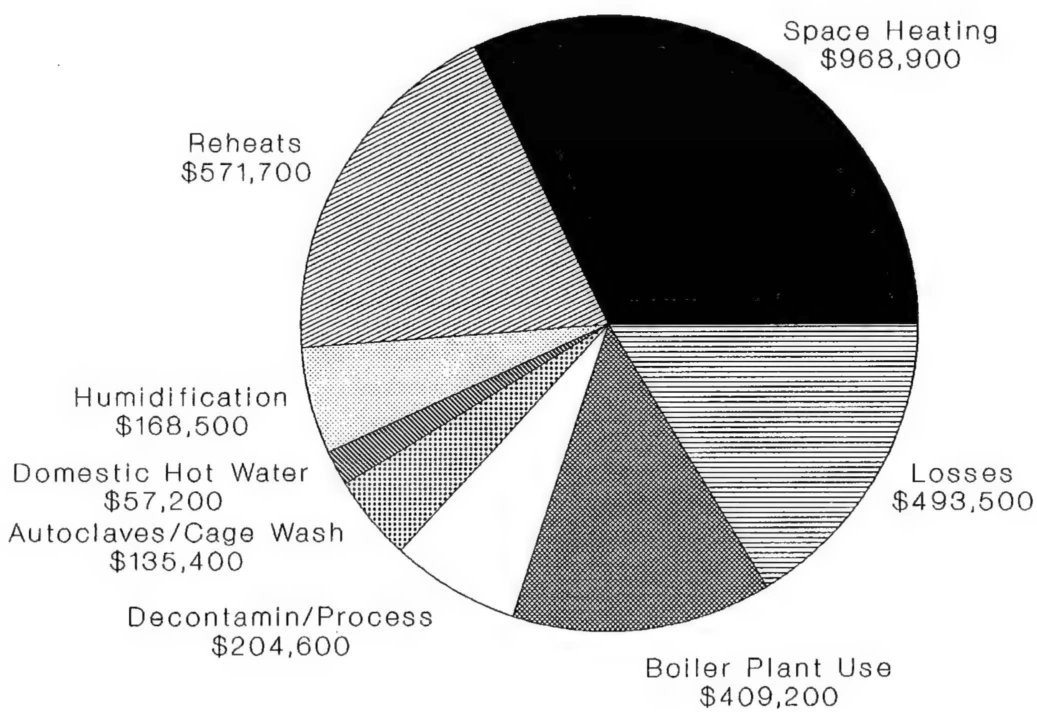


Figure 5.12.3

The fuel to steam efficiency is a common method of determining boiler performance, as per the American Society of Mechanical Engineers Power Test Code, ASME PTC 4.1-1964. One of the two methods evaluates the steam flow out of the boilers and compares it to the total fuel measured going into the boilers during operation. The other method is to determine all losses including combustion, radiation, blowdown, etc.

As stated previously in Section 4, data from the operator daily logs was used for determining these efficiencies. Fuel used to bank the boilers while on standby is not considered in these calculations. The definition that Entech uses for determining the fuel to steam efficiencies is as follows:

$$Efficiency\ (percent) = \frac{Steam\ Out}{Fuel\ in} \ x\ 100$$

Table 5.12.4 summarizes the five boilers and their efficiencies on natural gas and No. 6 fuel oil individually and combined. Boilers 1 and 2 as expected have the better efficiencies in the range of 79-83%, while the plant's workhorse, Boiler No. 3, has an average efficiency of 75%. Of the two older, Boilers No. 6 has a better efficiency than Boiler No. 5 by approximately 7 percentage points.

Figure 5.12.5 is included to summarize the distribution of costs associated with each boiler.

The table uses the log data for steam (mlbs), natural gas (mcf) and No. 6 fuel oil (gallons), and each are converted to energy (mmBtu). The method for identifying

the efficiencies begins first with realizing that boilers of this nature are inherently more efficient on No. 6 fuel oil than on natural gas by 2 to 3 percentage points. The next step was to perform an iterative calculation to fine tune efficiencies that balanced the distribution of energy in a realistic manner. The method is to select an efficiency for fuel oil and let the natural gas efficiency calculate a value while balancing the energy.

The efficiencies shown are both realistic and accurate in terms of tracking the energy totals. In most cases, minor adjustments to the oil efficiency renders the natural gas efficiency unrealistic, either higher or lower.

# 1994 Fuel to Steam Efficiencies
# Log Data – Boilers #1 thru #6

**Figure 5.12.4**

| Boiler | Steam Generation | | Gas to Steam | | | No. 6 Oil to Steam | | | Total Fuel to Steam | | Boiler |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (mlbs) | (mmBtu) | (mcf) | (mmBtu) | Eff. (%) | (gal) | mmBtu | Eff. (%) | mmBtu | Eff. (%) | |
| 1 | 133,543 | 134,345 | 165,372 | 170,333 | **78.7%** | 2,617 | 392 | **81.3%** | 170,724 | **78.7%** | 1 |
| 2 | 159,355 | 160,311 | 189,680 | 195,370 | **80.3%** | 26,970 | 4,037 | **83.5%** | 199,407 | **80.4%** | 2 |
| 3 | 277,088 | 278,751 | 171,232 | 176,368 | **73.5%** | 1,288,239 | 192,836 | **77.3%** | 369,205 | **75.5%** | 3 |
| 5 | 50,566 | 50,869 | 47,226 | 48,643 | **68.5%** | 164,440 | 24,615 | **71.3%** | 73,258 | **69.4%** | 5 |
| 6 | 70,844 | 71,269 | 67,105 | 69,118 | **76.0%** | 156,594 | 23,441 | **79.9%** | 92,559 | **77.0%** | 6 |
| Totals | 691,397 | 695,545 | 640,613 | 659,832 | **76.8%** | 1,638,860 | 245,321 | **77.1%** | 905,153 | **76.8%** | Totals |

**1994 Total Fuel to Steam Eff.(%)=** **76.8%** (Steam Out of Boilers/Fuel In)
**1994 Total Boiler Plant Eff.(%)=** **66.4%** (Steam Out of Plant for Site Load/Total Fuel In)

**1994 Percentage of Steam Generated by Natural Gas=** **72.8%**
**1994 Percentage of Steam Generated by No. 6 Oil=** **27.2%**

# 1994 Fuel to Steam Costs
# Log Data – Boilers #1 thru #6

**Figure 5.12.5**

| Boiler | Steam Generation | | Gas to Steam | | | No. 6 Oil to Steam | | | Total Fuel to Steam | | Boiler |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (mlbs) | (%/Total mlbs) | (mcf) | Cost ($) | (%/Total Cost) | (gal) | Cost ($) | (%/Total Cost) | Cost ($) | (%) Total | |
| 1 | 133,543 | 19.3% | 165,372 | $583,761 | 19.8% | 2,617 | $1,099 | 0.0% | $584,861 | **19.8%** | 1 |
| 2 | 159,355 | 23.0% | 189,680 | $669,569 | 22.7% | 26,970 | $11,327 | 0.4% | $680,896 | **23.1%** | 2 |
| 3 | 277,088 | 40.1% | 171,232 | $604,447 | 20.5% | 1,288,239 | $541,060 | 18.3% | $1,145,508 | **38.8%** | 3 |
| 5 | 50,566 | 7.3% | 47,226 | $166,707 | 5.7% | 164,440 | $69,065 | 2.3% | $235,772 | **8.0%** | 5 |
| 6 | 70,844 | 10.2% | 67,105 | $236,881 | 8.0% | 156,594 | $65,769 | 2.2% | $302,650 | **10.3%** | 6 |
| Totals | 691,397 | 100.0% | 640,613 | $2,261,365 | 76.7% | 1,638,860 | $688,321 | 23.3% | $2,949,687 | **100.0%** | Totals |

**1994 Cost of Firing Boilers on Natural Gas=** **76.7%**
**1994 Cost of Firing Boilers on No. 6 Oil=** **23.3%**

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It is Entech's position that these efficiencies based on year round performance data from the logs are the best values for evaluating this plant. The one day testing of individual boilers utilizing either of the two methods proposed in ASME PTC 4.1-1964 would reflect efficiencies that may or may not match up closely with the year round values.

The plant has its boiler instrumentation calibrated at least one time a year according to the site's personnel. Instrument reading adjustment factors are determined, during their calibration, and then they are utilized by plant operators for establishing log data. While the performance of a one day test assures applicable instrument calibrations for that day, the conditions of fuel, equipment, weather, load, etc. varies greatly throughout the year. With this conclusion, Entech feels that utilizing data for the entire year is the better method for determining efficiencies.

For a comparison, Entech will use the results of a combustion test on No. 6 fuel oil for Boiler No. 3 to determine the equivalent fuel to steam efficiency for that day versus the yearly value. The combustion test on December 6, 1994, at a firing rating of 70% yielded a combustion efficiency of 83.3%. A copy of this test can be found in Attachment 8.6.

The yearly value for fuel to steam efficiency of 77.3% for Boiler No. 3 on No. 6 fuel oil estimated to breakdown as follows:

Breakdown of Losses for Boiler No. 3 (yearly average)

| | |
|---|---|
| Stack Losses | 16.9%* |
| Radiation Losses | 1.4%* |
| Unburned CH (hydrocarbons) | 2.7%* |
| Unburned CO (carbon Monoxide) | 0.2%* |
| Misc. Losses | 1.5% (estimated) |
| | 22.7% (losses) |

* Values are based on relative findings from the article called Results from the Nationwide Oil-Versus-Gas Boiler Test program referenced previously in this report.

As a comparison the fuel to steam efficiency for Boiler No. 3 on No. 6 fuel oil is estimated again based on the combustion test from December 6, 1994. The resulting efficiency of 78.1% is estimated to be very close to the yearly average of 77.3%.

Breakdown of Losses for Boiler No. 3 (December 6, 1994 test)

| | |
|---|---|
| Stack Losses | 16.7% (test data) |
| Radiation Losses | 1.4%* |
| Unburned CH (hydrocarbons) | 2.6%* |
| Unburned CO (carbon Monoxide) | 0.2%* |
| Misc. Losses | 1.5% (estimated) |
| | 21.9% (losses) |

To review, the article referenced above performed an analysis on tabulated results from the dual fuel testing of 65 comparable boilers across the country, and therefore is our basis for these (*) estimates. The miscellaneous losses can be

accounted for with minor differences in many variables including air, oil, and feedwater conditions.

From this comparison, Entech stands on the premise that the efficiencies determined within this model are considered sound and appropriate. Therefore, these values will be the basis for evaluating ECOs that affect fuel to steam efficiencies directly.

## 5.13 Lighting Model

Entech calculated a lighting model for the boiler plant. The model is based upon information collected during Entech's walk-through and is shown on the following pages in Table 5.13.1. From the light model, the average watts per square foot for the building is 2.4 (22,253 watts ÷ 11,200 sf) which is above average for most facilities. Overall, Entech found the lighting levels to be appropriate. Table 5.13.2 displays a summary of the monthly results

**Light Model Summary**
**Table 5.13.2**

| | Demand | Usage | Cost $ |
|---|---|---|---|
| Incandescent | 2.5 | 1,841 | $66 |
| Fluorescent/HPS | 21.5 | 16,162 | $570 |

**LIGHTING MODEL**
**FORT DETRICK BOILER PLANT**
**TABLE 5.13.1**

| ROOM OR AREA DESCRIPTION | FIXTURE TYPE (1) | LIGHT LEVELS (FC) | NO. OF FIX. | LAMPS PER FIXTURE | WATTS PER LAMP | TOTAL WATTS | HOURS PER WEEK | PERCENT OF KW ON-PEAK | DEMAND KW ON-PEAK | USAGE KWH PER MONTH | ELECTRIC COSTS MONTHLY DEMAND (KW) | MONTHLY USAGE (KWH) | MONTHLY COST $ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Boiler Plant – Building #190** | | | | | | | | | | | | | |
| Switchgear Room | 1.15 | | 2 | 2 | 40 | 184 | 168 | 95.0% | 0.2 | 134 | $1.57 | $3.22 | $4.79 |
| Emergency Generator Room | 1.15 | | 3 | 2 | 40 | 276 | 168 | 95.0% | 0.3 | 201 | $2.35 | $4.83 | $7.18 |
| Boiler Plant High Bay Area | 1.15 | | 18 | 1 | 400 | 8,280 | 168 | 95.0% | 7.9 | 6,037 | $70.56 | $144.89 | $215.45 |
| Boiler Plant Lower Level | 1.15 | | 8 | 1 | 400 | 3,680 | 168 | 95.0% | 3.5 | 2,683 | $31.36 | $64.40 | $95.75 |
| Boiler Plant Lower Level | 1.15 | | 7 | 1 | 1000 | 8,050 | 168 | 95.0% | 7.6 | 5,869 | $68.60 | $140.87 | $209.46 |
| Locker Room | 1.15 | | 2 | 2 | 40 | 184 | 168 | 95.0% | 0.2 | 134 | $1.57 | $3.22 | $4.79 |
| Control Panel Lights | 1.15 | | 2 | 2 | 75 | 345 | 168 | 95.0% | 0.3 | 252 | $2.94 | $6.04 | $8.98 |
| Operator Table | 1.15 | | 2 | 2 | 40 | 184 | 168 | 95.0% | 0.2 | 134 | $1.57 | $3.22 | $4.79 |
| Chemical Treatment Room | 1.15 | | 3 | 2 | 40 | 276 | 168 | 95.0% | 0.3 | 201 | $2.35 | $4.83 | $7.18 |
| Softner Room | 1.15 | | 1 | 2 | 40 | 92 | 168 | 95.0% | 0.1 | 67 | $0.78 | $1.61 | $2.39 |
| Outdoor HPS Light | 1.15 | | 1 | 1 | 150 | 173 | 84 | 50.0% | 0.1 | 63 | $0.77 | $1.51 | $2.28 |
| Boiler 5 & 6 Flood Lights | 1.15 | | 2 | 1 | 150 | 345 | 168 | 95.0% | 0.3 | 252 | $2.94 | $6.04 | $8.98 |
| Boiler #3 Burner/Control Panel | 1.15 | | 1 | 4 | 40 | 184 | 168 | 95.0% | 0.2 | 134 | $1.57 | $3.22 | $4.79 |
| Misc. Incandescant Lights | 1 | | 13 | 1 | 300 | 3,900 | 84 | 50.0% | 2.0 | 1,422 | $17.49 | $34.12 | $51.61 |
| Misc. Incandescant Lights | 1 | | 7 | 1 | 150 | 1,050 | 84 | 50.0% | 0.5 | 383 | $4.71 | $9.19 | $13.90 |
| Exit Signs | 1 | | 2 | 1 | 25 | 50 | 168 | 95.0% | 0.0 | 36 | $0.43 | $0.87 | $1.30 |
| TOTALS | | | 74 | | | 27,253 | | | 24 | 18,003 | $212 | $432 | $644 |

INCREMENTAL DEMAND COST $/KW = $8.97
INCREMENTAL USAGE COST $/KWH = $0.024

NOTE #1: FOR BALLASTED FIXTURES A BALLAST FACTOR OF 1.15 IS USED, INCANDESCENT FIXTURES USE 1.

**G:\PROJECTS\4130.03\SS\LMODEL.WK1** **27–Jun–95**

## 5.14 Electrical Model

An electric model, as described in Section 2.5.5, has been developed for the boiler plant and can be viewed in Table 5.14.1 on the following page. The model represents the current operation of the building as indicated by boiler plant personnel and observed by Entech. The model is employed to approximate the contribution from all electrical users to an annual electric cost. The electric model will be used in conjunction with all other models during subsequent calculations to determine future energy costs and savings. Table 5.14.2 summarizes the results of the electric model.

**Electric Model Cost Summary**
**Table 5.14.2**

| | |
|---|---|
| Boiler Fans | $27,011 |
| Pumping | $16,025 |
| Lighting | $7,683 |
| Miscellaneous | $2,790 |

The summary above in the Table 5.14.2 reflects that the boiler fans constitute approximately 50% of the total electrical yearly costs of $53,509. Pumping for boiler make-up consumes 30% of the yearly total. Based on the current area of the building the average cost per square foot is $4.78 ($53,509 ÷ 11,200). It is important to realize that the electric model is an approximation of the electricity used by each load. It shows general relationships and gives a reasonable allocation of electrical demand, usage and cost.

**Electric Model**
**Fort Detrick Boiler Plant**
**Table 5.14.1**

| No. | Description | Total Connected Load (KW) | Winter Demand KW/Month | Inter Demand KW/Month | Summer Demand KW/Month | Hours Per Day | Winter Usage KWH/Month | Hours Per Day | Inter Usage KWH/Month | Hours Per Day | Summer Usage KWH/Month | Annual Demand KW/Yr. | Annual Usage KWH/Yr. | Annual Cost $/Yr. | No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Lighting | 27.3 | 24.0 | 24.0 | 24.0 | | 18,008 | | 18,008 | | 18,008 | 288 | 216,096 | $7,770 | 1 |
| 2 | | | | | | | | | | | | | | | 2 |
| 3 | ***Boiler Fans*** | | | | | | | | | | | | | | 3 |
| 4 | #3 Forced Draft (F.D.) Fan | 37.3 | 29.8 | 18.7 | 0.0 | 16.0 | 17,904 | 10.0 | 11,190 | 0.0 | 0 | 194 | 116,376 | $4,533 | 4 |
| 5 | #5 F.D. Fan | 11.2 | 2.8 | 2.8 | 5.6 | 3.0 | 1,007 | 3.0 | 1,007 | 8.0 | 2,686 | 45 | 18,799 | $853 | 5 |
| 6 | #6 F.D. Fan | 22.4 | 5.6 | 1.4 | 1.4 | 3.0 | 2,014 | 1.0 | 671 | 1.0 | 671 | 34 | 13,428 | $623 | 6 |
| 7 | #1 F.D. Fan | 29.8 | 7.5 | 14.9 | 14.9 | 6.0 | 5,371 | 10.0 | 8,952 | 12.0 | 10,742 | 149 | 100,262 | $3,745 | 7 |
| 8 | #2 F.D. Fan | 29.8 | 7.5 | 14.9 | 14.9 | 6.0 | 5,371 | 10.0 | 8,952 | 12.0 | 10,742 | 149 | 100,262 | $3,745 | 8 |
| 9 | #3 Induced Draft (I.D.) Fan | 74.6 | 59.7 | 37.3 | 0.0 | 16.0 | 35,808 | 12.0 | 26,856 | 0.0 | 0 | 388 | 250,656 | $9,495 | 9 |
| 10 | #5 I.D. Fan (Motor 1) | 22.4 | 5.6 | 5.6 | 11.2 | 3.0 | 2,014 | 4.0 | 2,686 | 12.0 | 8,057 | 90 | 51,026 | $2,028 | 10 |
| 11 | #5 I.D. Fan (Motor 2) | 14.9 | 3.7 | 3.7 | 7.5 | 3.0 | 1,343 | 4.0 | 1,790 | 10.0 | 4,476 | 60 | 30,437 | $1,266 | 11 |
| 12 | #6 I.D. Fan | 22.4 | 5.6 | 1.4 | 1.4 | 3.0 | 2,014 | 4.0 | 2,686 | 4.0 | 2,686 | 34 | 29,542 | $1,010 | 12 |
| 13 | | | | | | | | | | | | | | | 13 |
| 14 | ***Boiler Feedwater Pumps*** | | | | | | | | | | | | | | 14 |
| 15 | FWP-1 | 29.8 | 0.0 | 14.9 | 14.9 | 0.0 | 0 | 2.0 | 1,790 | 2.0 | 1,790 | 119 | 14,323 | $1,414 | 15 |
| 16 | FWP-2 | 29.8 | 0.0 | 22.4 | 22.4 | 0.0 | 0 | 18.0 | 16,114 | 18.0 | 16,114 | 179 | 128,909 | $4,700 | 16 |
| 17 | FWP-3 | 29.8 | 14.9 | 0.0 | 0.0 | 4.0 | 3,581 | 0.0 | 0 | 0.0 | 0 | 60 | 14,323 | $879 | 17 |
| 18 | FWP-4 | 37.3 | 28.0 | 0.0 | 0.0 | 18.0 | 20,142 | 0.0 | 0 | 0.0 | 0 | 112 | 80,568 | $2,937 | 18 |
| 19 | FWP-5 | 37.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | $0 | 19 |
| 20 | | | | | | | | | | | | | | | 20 |
| 21 | ***Makeup Water Pumps*** | | | | | | | | | | | | | | 21 |
| 22 | MWP-1 | 2.2 | 0.0 | 1.7 | 1.7 | 0.0 | 0 | 18.0 | 1,209 | 18.0 | 1,209 | 13 | 9,668 | $352 | 22 |
| 23 | MWP-2 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | $0 | 23 |
| 24 | MWP-3 | 2.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | $0 | 24 |
| 25 | MWP-1 (Inline) | 7.5 | 3.7 | 0.0 | 0.0 | 18.0 | 4,028 | 0.0 | 0 | 0.0 | 0 | 15 | 16,114 | $521 | 25 |
| 26 | MWP-2 (Inline) | 7.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | $0 | 26 |
| 27 | | | | | | | | | | | | | | | 27 |
| 28 | ***Fuel Oil Pumps*** | | | | | | | | | | | | | | 28 |
| 29 | FOP-1 | 7.5 | 3.7 | 3.7 | 0.0 | 18.0 | 4,028 | 18.0 | 4,028 | 0.0 | 0 | 30 | 32,227 | $1,041 | 29 |
| 30 | FOP-2 | 7.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | $0 | 30 |
| 31 | FOP-3 | 5.6 | 1.4 | 0.3 | 0.0 | 10.0 | 1,679 | 1.0 | 168 | 0.0 | 0 | 7 | 7,385 | $237 | 31 |
| 32 | FOP-4 | 5.6 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | $0 | 32 |
| 33 | FOP-A (Exist. Pumphouse) | 14.9 | 7.5 | 3.7 | 0.0 | 2.0 | 895 | 1.0 | 448 | 0.0 | 0 | 45 | 5,371 | $530 | 33 |
| 34 | FOP-B (Exist. Pumphouse) | 14.9 | 3.7 | 1.2 | 0.0 | 1.0 | 448 | 1.0 | 448 | 0.0 | 0 | 20 | 3,581 | $263 | 34 |
| 35 | FOP-X (Old Pumphouse) | 14.9 | 7.5 | 3.7 | 0.0 | 1.0 | 448 | 1.0 | 448 | 0.0 | 0 | 45 | 3,581 | $487 | 35 |
| 36 | FOP-Y (Old Pumphouse) | 14.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | $0 | 36 |
| 37 | FOP-Z (Old Pumphouse) | 14.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0 | 0 | $0 | 37 |
| 38 | | | | | | | | | | | | | | | 38 |
| 39 | ***Chemical Feed Pumps*** | | | | | | | | | | | | | | 39 |
| 40 | CFP-1 | 0.2 | 0.1 | 0.1 | 0.1 | 15.0 | 84 | 15.0 | 84 | 15.0 | 84 | 2 | 1,007 | $38 | 40 |
| 41 | CFP-2 | 0.2 | 0.1 | 0.1 | 0.1 | 15.0 | 84 | 15.0 | 84 | 15.0 | 84 | 2 | 1,007 | $38 | 41 |
| 42 | CFP-3 | 0.2 | 0.1 | 0.1 | 0.1 | 15.0 | 84 | 15.0 | 84 | 15.0 | 84 | 2 | 1,007 | $38 | 42 |
| 43 | CFP-4 | 0.1 | 0.1 | 0.1 | 0.1 | 15.0 | 56 | 15.0 | 56 | 15.0 | 56 | 1 | 671 | $25 | 43 |
| 44 | | | | | | | | | | | | | | | 44 |
| 45 | ***Miscellaneous*** | | | | | | | | | | | | | | 45 |
| 46 | CP-1 (Condensate Pump) | 7.5 | 5.6 | 5.6 | 5.6 | 12.0 | 2,686 | 12.0 | 2,686 | 12.0 | 2,686 | 67 | 32,227 | $1,376 | 46 |
| 47 | CP-2 (Condensate Pump) | 7.5 | 3.7 | 1.9 | 1.9 | 6.0 | 1,343 | 4.0 | 895 | 4.0 | 895 | 30 | 12,533 | $568 | 47 |
| 48 | SP-1 (Sump for Cond. Pit) | 0.7 | 0.6 | 0.4 | 0.3 | 3.0 | 67 | 2.0 | 45 | 2.0 | 45 | 5 | 627 | $60 | 48 |
| 49 | SWP-1 (Softner Water Pump) | 5.6 | 4.2 | 1.4 | 1.4 | 3.0 | 504 | 2.0 | 336 | 1.5 | 252 | 28 | 4,364 | $356 | 49 |
| 50 | EF-A(Soft. Room Exh. Fan) | 0.4 | 0.3 | 0.3 | 0.3 | 18.0 | 201 | 18.0 | 201 | 18.0 | 201 | 3 | 2,417 | $88 | 50 |
| 51 | EF-B(Soft. Room Exh. Fan) | 1.5 | 1.1 | 1.1 | 1.1 | 18.0 | 806 | 18.0 | 806 | 18.0 | 806 | 13 | 9,668 | $352 | 51 |
| 52 | Hot Water Heater | 4.5 | 3.4 | 3.4 | 3.4 | 12.0 | 1,620 | 12.0 | 1,620 | 12.0 | 1,620 | 41 | 19,440 | $830 | 52 |
| 53 | AC-1 (Air Compressor) | 7.5 | 5.6 | 5.6 | 5.6 | 2.0 | 448 | 2.0 | 448 | 2.0 | 448 | 67 | 5,371 | $731 | 53 |
| 54 | AC-2 (Air Compressor) | 7.5 | 5.6 | 5.6 | 5.6 | 2.0 | 448 | 2.0 | 448 | 2.0 | 448 | 67 | 5,371 | $731 | 54 |
| 55 | AD-1 (Air Dryer) | 0.4 | 0.3 | 0.3 | 0.3 | 2.0 | 22 | 2.0 | 22 | 2.0 | 22 | 3 | 269 | $37 | 55 |
| 56 | AD-2 (Air Dryer) | 0.4 | 0.3 | 0.3 | 0.3 | 2.0 | 22 | 2.0 | 22 | 2.0 | 22 | 3 | 269 | $37 | 56 |
| 57 | AN-1(Air Conditioner) | 1.5 | 0.0 | 0.0 | 1.1 | 0 | 0 | 0 | 0 | 18.0 | 806 | 4 | 3,223 | $117 | 57 |
| 58 | AN-2(Air Conditioner) | 1.5 | 0.0 | 0.0 | 1.1 | 0 | 0 | 0 | 0 | 18.0 | 806 | 4 | 3,223 | $117 | 58 |
| | TOTALS | 626 | 253 | 203 | 148 | | 134,577 | | 115,286 | | 86,544 | 2,416 | 1,345,600 | $53,428 | |

INCREMENTAL DEMAND COST $/KW = 8.97
INCREMENTAL USAGE COST $/KWH = 0.024

WINTER: DEC, JAN, FEB, MAR
INTER: APR, MAY, OCT, NOV
SUMMER: JUN, JUL, AUG, SEP

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## 6.0 ENERGY CONSERVATION OPPORTUNITIES

### 6.1 General

The items discussed in this section of the report are the result of investigation of many energy cost reduction strategies.

**Existing**, discusses the current operational energy levels and approximate costs.

**Proposed**, presents a new concept designed to save energy; however, it should be understood that the actual design has not yet been performed. Arrangements and quantities may change somewhat during final design.

**Construction Costs**, covers materials, labor, and indirect costs needed for a complete project, including associated engineering design and construction management costs. Escalation is not included. Costs are in 1995 dollars.

**Savings**, shows an expected level of annual energy and cost savings; however does not include price increases of various energy sources or interactive savings. The ECOs are calculated on a stand alone basis.

**Maintenance Savings,** estimate of the proposed maintenance savings resulting from implementing the ECO.

**Discussion**, notes the results of the life cycle costs (LCCID) summary.

## 6.2 ECO List

The following descriptions summarize the various categories of ECOs being reviewed at Fort Detrick.

ECO Categories:

1. (B) Boiler Systems/Controls - ECOs that pertain to the direct operation of the boilers and their control in the Boiler Plant.

2. (O) Operation - These are ECOs that are performed to analyze alternate methods for selecting and utilizing boilers and fuels.

3. (S) Site - Possible ECOs associated with improvements that could be made at the Fort Detrick site that would have a direct impact on the Boiler Plant.

4. (P) Plant - ECOs associated with electrical and/or steam consumption within the Boiler Plant, excluding lighting.

5. (L) Lighting - ECOs addressing lighting in the Boiler Plant.

Table 6.2.1 is the complete list of 30 ECOs considered for this study. All but one of the ECOs were evaluated for Energy Savings Opportunities. ECO S-5, Correct Sizing of Traps, was eliminated from further review based on an agreement between Fort Detrick and Entech. Backup information if provided for each ECO is included in Attachment 8.5.

**Fort Detrick ECO List**
**Table 6.2.1**

| Category | No. | Title |
|---|---|---|
| (B) Boiler Systems/Controls | B-1 | Feedwater Treatment |
| | B-2 | Stack Economizers |
| | B-3 | Automatic Blowdown Controls |
| | B-4 | New Burners |
| | B-5 | Oxygen ($O_2$) Trim Controls on Boilers |
| | B-6 | Air Preheaters |
| | B-7 | Supply Combustion Air from Ceiling |
| | B-8 | Update Instruments & Controls |
| | B-9 | New Steam Metering |
| (O) Operations | O-1 | Shut off Standby Boilers |
| | O-2 | Improve Boiler Sequencing |
| | O-3 | Summer Shutdown of Boiler Plant |
| | O-4 | Replace Less Efficient Boilers |
| | O-5 | Fuel Usage Election Plan |
| | O-6 | Alternate Fuels (Natural Gas Brokering) |
| (S) Site | S-1 | Cogeneration |
| | S-2 | New Boiler Plant |
| | S-3 | Steam Pressure Reduction |
| | S-4 | Improve Condensate Return |
| | S-5 | Correct Sizing of Traps (Deleted from scope) |
| | S-6 | Steam & Condensate Metering |
| | S-7 | Insulate Steam & Condensate Lines |

| Category | No. | Title |
|---|---|---|
| | S-8 | Replace Steam Humidification Ultrasonic |
| | S-9 | Sewage Storage Tank Insulation |
| | S-10 | Reduce Contaminated Sewage |
| (P) Plant | P-1 | Turbine Drives on Feedwater Pumps |
| | P-2 | Efficient Motors |
| | P-3 | Variable Speed Drives |
| (L) Lighting | L-1 | Boiler Plant Lighting |
| | L-2 | Exit Signs to Fluorescent |

The ECOs as evaluated follow in Sections 6.3 through 6.7. Each section groups the ECOs in the five categories described previously. The ECOs will then be summarized as a whole, and then categorized as recommended versus non-recommended in Section 7 following the evaluations.

### 6.3 (B) Boiler Systems/Controls

The following section contains the evaluations for the ECOs investigating the Boiler Plant Systems and their Controls. They are ECOs B-1 through B-9.

B-1 Feedwater Treatment
B-2 Stack Economizers
B-3 Automatic Blowdown Controls
B-4 New Burners
B-5 Oxygen ($O_2$) Trim Controls on Boilers
B-6 Air Preheaters
B-7 Supply Combustion Air from Ceiling
B-8 Update Instruments & Controls
B-9 New Steam Metering

## ECO B-1
## FEEDWATER TREATMENT

**Existing.** Presently, the Fort Detrick Boiler Plant spends about $60,000 per year for water treatment of the boiler feedwater. The chemical treatment includes using injection pumps and water softeners. With this treatment, the estimated blowdown rate for the boiler to maintain the proper conductivity level is 4% (3-5%) of the total feedwater. The blowdown rate is verified once a month by Betz Entec, the chemical treatment consultant for the plant.

**Proposed.** Make improvements to the chemical treatment for the boilers in order to reduce blowdown.

**Construction Cost.** There is no construction cost associated with this energy conservation opportunity.

**Savings.** None. make up water would go down

**Discussion.** After reviewing the existing treatment system, and after interviewing the Boiler Plant manager and the chemical treatment representative, it is Entech's opinion that the plant has a good treatment process in place. There are not any appreciable energy savings associated with increased chemical treatment.

# ECO B-2
# STACK ECONOMIZERS

**Existing.** Boiler Stack Economizers are presently installed on Boilers No. 1, No. 2, and No.3. They are not installed on Boilers No. 5 and No. 6. In all three cases where economizers are installed, preheaters are used to raise the feedwater temperature from 220°F to 250°F prior to entering the economizer. This practice is used to ensure that the stack gases will not condense on the water coils, which can cause corrosion because of the acidic nature of the stack gases. The economizers on Boilers No. 1 and No. 2 raise the temperature from 250°F to approximately 280°F, with typical gas temperatures entering the economizers in the range of 350°F to 400°F. The economizer on Boiler No. 3, with economizer entering stack temperatures in the range of 450°F to 550°F, raises the feedwater to approximately 320°F. The estimated fuel use for Boilers No. 5 and No. 6 is as follows:

Steam Produced = 121,400 mlb/yr

$$\left(50{,}556\ \frac{mlb}{yr}\ (\text{N}^{\underline{o}}5) + 70{,}844\ \frac{mlb}{yr}\ (\text{N}^{\underline{o}}6)\right) = 121{,}410\ \textit{use,}\ 121{,}400\ \frac{mlb}{yr}$$

Natural Gas = 122,485 mcf/yr

$$\left(51{,}345\ \frac{mcf}{yr} + 71{,}140\ \frac{mcf}{yr}\right) = 122{,}485\ \frac{mcf}{yr}$$

No. 6 Fuel Oil = 322,121 gal/yr

$$\left(164{,}777\ \frac{gal}{yr} + 157{,}344\ \frac{gal}{yr}\right) = 322{,}121\ \frac{gal}{yr}$$

Fuel Cost = \$567,700

$$\left(122{,}485\frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(322{,}121\frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$567{,}663\ \textit{use}\ \$567{,}700$$

**Proposed.** Install stack economizers on Boilers No. 5 and No.6 to take advantage of the high flue gas temperatures to heat feedwater. The conditions expected with this installation include a preheater raising the 220°F water to 250°F, similar to Boiler No. 3, and economizer exit temperatures of 300°F or better. The steam generated and the revised fuel costs associated with the economizer arrangement is shown below. It will be assumed that natural gas will be used to fuel the additional steam demand. From Table 5.12.4, the average efficiencies for Boilers No.5 and No.6 on natural gas and No. 6 fuel oil are 72.7% and 75.6% respectively. With the installation of the economizers with preheaters, the combined efficiencies are estimated to be 75% and 78%. Assuming the steam demand to be the same, the fuel cost for operating Boilers No. 5 and No. 6 with the economizers installed would be approximately $550,100.

Steam Produced = 125,100 mlb/yr = Existing Steam Produced + Steam Required to Pre-heat Feedwater

$$121{,}400\ \frac{mlb}{yr} + \left( \frac{121{,}400\frac{mlb}{yr}\ x\ 1.04(feedwater)\ x \left(218\ -\ 188\frac{Btu}{lb}\right)}{\left(1{,}191\ -\ 168\frac{Btu}{lb}\right)} \right) = 125{,}102,\ use\ 125{,}100\frac{mlb}{yr}$$

NOTE: Feedwater (1.04) = Steam (1.0) + Blowdown (0.04)

Natural Gas = 118,700 mcf/yr

$$\left(122{,}485\ \frac{mcf}{yr}\ x\ \frac{.727}{.75}\right) = 118{,}728\ use,\ 118{,}700\frac{mcf}{yr}$$

No. 6 Fuel Oil = 312,200 gal/yr

$$\left(322{,}121\ \frac{gal}{yr}\ x\ \frac{.756}{.78}\right) = 312{,}210\ use,\ 312{,}200\ \frac{gal}{yr}$$

Fuel Cost = $550,100

$$\left(118{,}000\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(312{,}000\ \frac{gal}{yr}\ x\ 0.42\right) = \$550{,}135\ use,\ \$550{,}100$$

**Construction Cost.** The expected construction cost associated with this project is $253,000. Reference the cost estimate attached.

| | |
|---|---|
| Material | $169,000 |
| Labor | 58,000 |
| Design Fee | 14,000 |
| SIOH | 12,000 |
| Total | $253,000 |

**Savings.** The expected savings is $16,500. A summary of the savings associated with changes to Boilers No. 5 and No. 6 is as follows:

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Steam (mlb/yr) | 121,400 | 125,100 | -3,700 | -3.1% |
| Natural Gas (mcf/yr) | 122,485 | 118,700 | 3,785 | -3.1% |
| No. 6 Fuel Oil (gal/yr) | 322,121 | 312,200 | 9,921 | -3.1% |
| Energy Usage (mmBtu/yr) | 174,400 | 169,000 | 5,400 | -3.1% |
| Fuel Cost | $567,700 | $550,200 | $16,500 | -2.9% |

**Maintenance Savings.** The annual maintenance cost (-savings) for this ECO is $10,000.

**Discussion.** Payback Period = 34 years

Savings to Investment Ratio = 0.85

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-2 STACK ECONOMIZERS
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 227000. | | |
| B. SIOH | $ 12000. | | |
| C. DESIGN COST | $ 14000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 253000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 253000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 1485. | $ 4173. | 19.97 | $ 83332. |
| D. NAT G | $ 3.43 | 3899. | $ 13374. | 20.96 | $ 280310. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 5384. | $ 17546. | | $ 363642. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -10000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -147400.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -147400.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 7546.

5. SIMPLE PAYBACK PERIOD (1G/4) 33.53 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 216242.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .85
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 2.29 %

# ECO B-3
# AUTOMATIC BLOWDOWN CONTROLS

**Existing.** According to the Fort Detrick water quality consultant, Betz Entec, the estimated blowdown for the boilers is 4% of the total feedwater. The method of maintaining the continuous blowdown of the boiler is to set the appropriate pinch valve for the boiler located near the blowdown flash tank. Tests are done daily to evaluate the alkalinity of the water in the boiler, and the pinch valve is adjusted accordingly. This practice, while not automatic by definition, is sound and lends to maintaining consistent blowdown rates, as verified by Betz Entec.

The overal efficiency for the boilers is 76.8%. For simplification, the calculation will disregard heat gained in economizers. This assumption will slightly over estimate savings and payback. The energy cost to heat makeup water required to offset the blowdown is estimated to be $37,700 per year.

Feedwater Total = 720,205 mlb/yr (from Table 5.9.1)

Blowdown Total = 28,800 mlb/yr

$$\left(720{,}205\ \frac{mlb}{yr}\ x\ 0.04\right) = 28{,}808\ use,\ 28{,}800\ \frac{mlb}{yr}$$

Blowdown Energy = 8,440 mmBtu/yr
(from 60°F to 350°F)

$$\left(28{,}800\frac{mlb}{yr}\ x\ 1{,}000\frac{lb}{mlb}\ x\ \left(321\frac{btu}{lb} - 28\frac{btu}{lb}\right) \div 1{,}000{,}000\frac{Btu}{mmBtu}\right) = 8{,}438\ use,\ 8{,}440\ \frac{mmBtu}{yr}$$

Natural Gas = 10,670 mcf/yr
(for blowdown energy)

$$\left(8{,}440\ \frac{mmBtu}{0.768}\ x\ \frac{1\ mcf}{1.03\ mmBtu}\right) = 10{,}669\ use,\ 10{,}670\ \frac{mcf}{yr}$$

Blowdown Cost = $37,700

$$\left(10{,}670\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) = \$37{,}665\ \textit{use},\ \$37{,}700$$

**Proposed.** Install automatic blowdown controls on all five boilers to reduce blowdown. It is Entech's position that the present method is fairly effective and that automatic blowdown would control the total to 3%. The estimated cost for heating blowdown would be $27,900 per year.

Feedwater Total = 713,000 mlb/yr

$$\left(720{,}205\ \frac{mlb}{yr}\ x\ .99\right) = 713{,}000\ \frac{mlb}{yr}$$

NOTE: 99% Feedwater = 1% reduction in blowdown (4%-3%)

Blowdown Total = 21,400 mlb/yr

$$\left(713{,}000\ \frac{mlb}{yr}\ x\ 0.03\right) = 21{,}390\ \textit{use},\ 21{,}400\ \frac{mlb}{yr}$$

Blowdown Energy = 6,270 mBtu/yr
(from 60°F to 350°F)

$$\left(21{,}400\frac{mlb}{yr}\ x\ 1{,}000\frac{lb}{mlb}\ x\left(321\frac{btu}{lb} - 28\frac{btu}{lb}\right) \div 1{,}000{,}000\frac{Btu}{mmBtu}\right) = 6{,}270\ \frac{mmBtu}{yr}$$

Efficiency = 77.2%

$$\frac{Steam\ \ Generated}{ExistingFuel\text{-}FuelSaved} = \frac{\left(691{,}397 mmlb\ x\ 1.003\ \frac{mmBtu}{mlb}\right)}{\left(\frac{691{,}397\ mlb\ x\ 1.003\ \frac{mmBtu}{mlb}}{.768}\right) - (\ 10{,}670\ mmBtu\ -\ 6{,}270\ mmBtu\ )}$$

Natural Gas = 7,890 mcf/yr
(for blowdown energy)

$$\left(6{,}270\ \frac{mmBtu}{yr}\ x\ \frac{1\ mcf}{1.03\ mmBtu}\right) = 7{,}885\ use,\ 7{,}890\ \frac{mcf}{yr}$$

Blowdown Cost = $27,900 year

$$\left(7{,}890\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) = \$27{,}852\ use,\ \$27{,}900$$

**Construction Cost.** The estimated construction cost for implementing this energy conservation opportunity on all five boilers is $145,000.

| | |
|---|---|
| Material | $77,000 |
| Labor | 53,000 |
| Design Fee | 8,000 |
| SIOH | 7,000 |
| Total | $145,000 |

**Savings.** The estimated cost savings resulting from the implementation of this project will be $9,800 per year.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Blowdown rate (%) | 4% | 3% | 1% | 25% |
| Feedwater (mlbs/yr) | 720,200 | 712,800 | 7,400 | 1.0% |
| Natural Gas (mcf/yr) | 10,670 | 7,890 | 2,780 | 26.0% |
| Energy Usage (mmBtu) | 10,990 | 8,130 | 2,860 | 26.0% |
| Energy Cost | $37,700 | $27,900 | $9,800 | 26.0% |

**Maintenance Savings.** The annual maintenance and operation savings expected with this ECO is $3,000.

**Discussion.** Payback Period = 11 years

Savings to Investment Ratio = 1.72

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

Based on the practices used presently, and from interviewing the water treatment consultant it is our recommendation not to proceed with this ECO.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-3 AUTOMATIC BLOWDOWN CONTROLS
ANALYSIS DATE: 07-21-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 130000. | | |
| B. SIOH | $ 7000. | | |
| C. DESIGN COST | $ 8000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 145000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 145000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 2860. | $ 9810. | 20.96 | $ 205613. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 2860. | $ 9810. | | $ 205613. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 3000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 44220.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 44220.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 12810.

5. SIMPLE PAYBACK PERIOD (1G/4) 11.32 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 249833.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.72
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 5.94 %

## ECO B-4
## NEW BURNERS

**Existing.** The existing burners on the five boilers at Fort Detrick are approximately fifteen (15) years or less in age. Boilers No. 1 and No. 2 are packaged watertube boilers which utilize a single gun - forced draft burner. These boilers were installed in 1991.

The original fuel oil burners on Boilers No. 3, No. 5 & No. 6 were replaced with combination fuel burners, natural gas and No. 6 fuel oil, in the early 1980's.

The condition for all of these burners appears to be good.

For this ECO, Entech will analyze the possibility of using new burners on Boiler No. 3 because it is the most heavily used boiler. In Section 5.12, we determined the overall efficiency of this boiler to be 75.5%.

The total amount of steam, fuel, and energy generated or consumed by Boiler No. 3 is as follows:

| | | |
|---|---|---|
| Steam Produced | = | 277,088 mlb/yr |
| Natural Gas | = | 171,232 mcf/yr |
| No. 6 Fuel Oil | = | 1,288,239 gal/yr |
| Fuel Cost | = | \$1,145,500/yr |

$$\left( 171{,}232 \ \frac{mcf}{yr} \ x \ \frac{\$3.53}{mcf} + 1{,}288{,}239 \ \frac{gal}{yr} \ x \ \$0.42 \right) = \$1{,}145{,}509 \ use, \ \$1{,}145{,}500 \ /yr$$

**Proposed.** Replace burners on Boiler No. 3 (4 burners) with new, more efficient burners. Such a change would also require $O_2$ controls to maintain low $NO_x$, but for this ECO, the burners themselves will be addressed for their savings and costs. The expected improvement in efficiency is approximately 1% for this change. The burners for Boilers No. 1 and No. 2 are not proposed to be changed since they are efficient

burners installed within the past four years. If the payback acceptable for Boiler No. 3, then the evaluation of Boilers No. 5 and No. 6 (3 burners each) ~~would follow~~. Assumming the same steam generated with a 1% improvement in overall efficiency, the estimated amount of fuel and energy totals for Boiler No. 3 would be as shown below.

IS THIS REALISTIC? WHERE FROM?

Total Efficiency = 76.5%

Steam Produced = 277,088 mlb/yr

Natural Gas = 169,000 mcf/yr

$$\left(171{,}232\ \frac{mcf}{yr}\ x\ \frac{.755}{.765}\right) = 168{,}994\ use,\ 169{,}00\frac{mcf}{yr}$$

No. 6 Fuel Oil = 1,271,400 gal/yr

$$\left(1{,}288{,}239\ \frac{gal}{yr}\ x\ \frac{.755}{.765}\right) = 1{,}271{,}400\ \frac{gal}{yr}$$

Fuel Energy = 364,380 mmBtu/yr

$$\left(369{,}205\ \frac{mmBtu}{yr}\ x\ \frac{.755}{.765}\right) = 364{,}380\ \frac{mmBtu}{yr}$$

Fuel Cost = $1,130,600 /yr

$$\left(169{,}000\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf} + 1{,}271{,}400\ \frac{gal}{yr}\ x\ \$0.42\ gal\right) = \$1{,}130{,}560\ use,\ \$1{,}131{,}600\ /yr$$

**Construction Cost.** The costs associated with implementing this energy conservation opportunity for Boiler No. 3 are $200,000.

| | |
|---|---|
| Material | $117,000 |
| Labor | 62,000 |
| Design Fee | 11,000 |
| SIOH | 10,000 |
| Total | $200,000 |

**Savings.** The cost savings expected with incorporating this ECO is $14,900.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 171,232 | 169,000 | 2,232 | 1.3% |
| No. 6 Fuel Oil (gal/yr) | 1,288,239 | 1,271,400 | 16,839 | 1.3% |
| Energy Usage (mmBtu/yr) | 369,205 | 364,380 | 4,825 | 1.3% |
| Fuel Cost | $1,145,500 | $1,130,600 | $14,900 | 1.3% |

**Maintenance Savings.** The maintenance savings expected with this ECO is $0.

**Discussion.** Payback Period = 13 years

Savings to Investment Ratio = 1.5

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

This ECO is not recommended for Boiler No. 3 and therefore, not for Boilers No. 5 and No. 6. The replacement of burners in the future may be required for environmental reasons, but presently it cannot be recommended based on energy savings.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-4 NEW BURNERS
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 179000. | | |
| B. SIOH | $ 10000. | | |
| C. DESIGN COST | $ 11000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 200000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 200000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 2521. | $ 7084. | 19.97 | $ 141468. |
| D. NAT G | $ 3.43 | 2299. | $ 7886. | 20.96 | $ 165282. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 4820. | $ 14970. | | $ 306749. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 0. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.74 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 0. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 14970.

5. SIMPLE PAYBACK PERIOD (1G/4) 13.36 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 306749.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.53
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 5.33 %

## ECO B-5
## OXYGEN ($O_2$) TRIM CONTROLS ON BOILERS

**Existing.** The five boilers at the Fort Detrick boiler plant presently do not have automatic oxygen controls for limiting excess air. Oxygen ($O_2$) analyzers for status only are installed on all five boilers, and of the five, only the analyzers for Boilers No. 1, No. 2, and No.3. are presently functional.

Excessive combustion air must be heated; resulting in increased flue gas losses (costs). The excess air calculations are based on the boilers overall efficiencies determined in Table 5.12.4. The theoretical amount of air needed for the combustion of natural gas is 720 lbs air/mmBtu (million Btu). The theoretical amount required for No. 6 oil is 750 lbs of air/mmBtu. To simplify calculations, the natural gas value of 720 lbs/mmBtu will be used for determining the excess air quantities. The boilers fire on natural gas approximately 75% of the time. Based on the overall efficiency of 78.7%, and a flue gas temperature of 450°F, Boiler No. 1 is estimated to use 25% excess air, or 180 lbs/mmBtu. This calculation is shown below as an example, and Table ECO B-5.1.1 follows, summarizing the excess air values and costs for all five boilers.

Boiler No. 1 Excess Air = 720 lbs/mmBtu x .25 = 180 lbs/mmBtu

From the billing history using boiler plant log data, Boiler No. 1 used 170,724 mmBtu/yr in fuel energy in 1994.

Energy Use = 170,724 mmBtu/yr

$$\left(165{,}372\ \frac{mcf}{yr}\ x\ \frac{1.03\ \ mmBtu}{mcf}\right) + \left(2{,}627\ \frac{gal}{yr}\ x\ \frac{0.149690\ \ mmBtu}{gal}\right) = 170{,}724\ \frac{mmBtu}{yr}$$

Of this total, 16,632 Btu/mmBtu of fuel consumed is used to heat the excess air. The standard equation and the calculation for Boiler No. 1 is as follows. The specific heat of air is assumed to be 0.24 Btu/lbm °R.

$$Ratio\ of \left( \frac{Btu\ (Excess\ Air\ Heat)}{mmBtu\ (Total\ Fuel\ In)} \right) = 16{,}632\ \frac{Btu}{mmBtu}$$

$$\left( 180\ \frac{lbs}{mmBtu}\ x\ 0.24\ \frac{Btu}{lbm^{\circ}R}\ x\ (450\ -\ 65^{\circ}F\ ) \right) = 16{,}632\ \frac{Btu}{mmBtu}$$

This value converts to a yearly total of 2,839 mmBtu/yr, or 2,757 mcf. The total cost to heat this air, assuming all natural gas, is $9,731. The total cost for all five boilers is calculated to be over $75,000 / yr.

Energy Usage = 2,839 mmBtu/yr
(for heating excess air)

$$\left( \left( 16{,}632 \frac{Btu}{mmBtu}\ x\ 170{,}724 \frac{mmBtu}{yr} \right) \div 1\ x\ 10^6\ \frac{Btu}{mmBtu} \right) = 2{,}839\ \frac{mmBtu}{yr}$$

Fuel Consumed = 2,757 mcf/yr

$$\left( 2{,}839\ \frac{mmBtu}{yr} \div 1.03\ \frac{mmBtu}{mcf} \right) = 2{,}757 \frac{mcf}{yr}$$

Fuel Cost = $9,731 /yr

$$\left( 2{,}757\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf} \right) = \$9{,}731\ /yr$$

The summary of estimated excess air for the existing five boilers follows in Table ECO B-5.1.1.

Existing – Estimated Excess Air
ECO B–5 (w/o O2 Trim Controls)
Table ECO B–5.1.1

| Boiler # | Total Fuel (mmBtu/yr) | Total Steam (mmBtu/yr) | Overall Eff. (%) | Est. Flue Gas (F) | Excess O2 (%) | Excess Air (%) | Excess Air (lb/mmBtu) | Excess Air (Btu/mmBtu) | Excess Air (mmBtu/yr) | Excess Air Energy (mcf/yr) | Excess Air Cost ($/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 170,724 | 134,345 | 78.7% | 450 | 5.0% | 25.0% | 180 | 16,632 | 2,839 | 2,757 | $9,731 |
| 2 | 199,407 | 160,311 | 80.4% | 450 | 2.5% | 15.0% | 108 | 9,979 | 1,990 | 1,932 | $6,820 |
| 3 | 369,205 | 278,751 | 75.5% | 550 | 6.0% | 32.0% | 230 | 26,819 | 9,902 | 9,613 | $33,934 |
| 5 | 73,258 | 50,869 | 69.4% | 500 | 11.5% | 100.0% | 720 | 75,168 | 5,507 | 5,346 | $18,872 |
| 6 | 92,559 | 71,269 | 77.0% | 500 | 5.0% | 25.0% | 180 | 18,792 | 1,739 | 1,689 | $5,961 |
| | | | | | | Totals | 1,418 | 147,390 | 21,977 | 21,337 | $75,319 |

Proposed – Estimated Excess Air
ECO B–5 (w/ O2 Trim Controls)
Table ECO B–5.1.2

| Boiler # | Total Fuel (mmBtu/yr) | Est.Tot. Steam (mmBtu/yr) | Est. Overall Eff. (%) | Est. Flue Gas (F) | Excess O2 (%) | Excess Air (%) | Excess Air (lb/mmBtu) | Excess Air (Btu/mmBtu) | Excess Air (mmBtu/yr) | Excess Air Energy (mcf/yr) | Excess Air Cost ($/yr) | Reduction Cost ($/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 170,724 | 138,286 | 81.0% | 450 | 1.5% | 10.0% | 72 | 6,653 | 1,136 | 1,103 | $3,893 | $5,839 |
| 2 | 199,407 | 161,520 | 81.0% | 450 | 1.5% | 10.0% | 72 | 6,653 | 1,327 | 1,288 | $4,547 | $2,273 |
| 3 | 369,205 | 284,288 | 77.0% | 550 | 2.0% | 15.0% | 108 | 12,571 | 4,641 | 4,506 | $15,907 | $18,028 |
| 5 | 73,258 | 57,141 | 78.0% | 500 | 3.0% | 25.0% | 180 | 18,792 | 1,377 | 1,337 | $4,718 | $14,154 |
| 6 | 92,559 | 73,122 | 79.0% | 500 | 2.0% | 15.0% | 108 | 11,275 | 1,044 | 1,013 | $3,577 | $2,384 |
| | | | | | | Totals | 540 | 55,944 | 9,524 | 9,247 | $32,641 | $42,679 |

G:\PROJECTS\4130.03\SS\ECO–B5.WK1

**Proposed.** Install oxygen ($O_2$) trim controls on all five boilers, which would provide automatic control of combustion air quantities. Reasonable expectations with this arrangement is to reduce excess air to a level between 10-25% on boilers of this size and type. An example calculation is shown below for determining the fuel consumed for heating excess air with $O_2$ controls on Boiler No. 1.

The level of excess air projected for this boiler is 10%. The calculation will summarize the same amount of fuel burned which in turn allows for more steam production. The excess air of 10% then calculates to be 72 lbs/mmBtu, of 5,322 Btu/mmBtu.

Boiler No. 1 - Excess Air 57.6 lbs/mmBtu

$$\left(720 \frac{lbs}{mmBtu} \times .10\right) = 72 \frac{lbs}{mmBtu}$$

$$\left(72 \frac{lbs}{mmBtu} \times 0.24 \frac{Btu}{lbm^\circ R} \times (450 - 65^\circ F)\right) = 6{,}653 \frac{Btu}{mmBtu}$$

From the proposed excess air rate, the total energy usage, fuel usage, and fuel costs are as follows:

Energy Usage = 1,136 mmBtu/yr
(for heating excess air)

$$\left(\left(6{,}653 \frac{Btu}{mmBtu} \times 170{,}724 \frac{mmBtu}{yr}\right) \div 1 \times 10^6 \frac{Btu}{mmBtu}\right) = 1{,}136 \frac{mmBtu}{yr}$$

Natural Gas = 1,103 mcf/yr

$$\left(1{,}136 \frac{mmBtu}{yr} \div 1.03 \frac{mmBtu}{mcf}\right) = 1{,}103 \frac{mcf}{yr}$$

Fuel Cost = \$3,894 /yr

$$\left(1{,}103\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) = \$3{,}894\ /yr$$

For a summary of proposed estimated excess air for the existing five boilers see the previous Table ECO B-5.1.2.

**Construction Cost.** The estimated construction cost associated with implementing this ECO on Boiler No. 3 only is \$75,000.

| | |
|---|---|
| Material | \$39,000 |
| Labor | 28,000 |
| Design Fee | 4,000 |
| SIOH | 4,000 |
| Total | \$75,000 |

**Savings.** The estimated total savings for implementing this project on Boiler No. 3 only is \$18,028. The summary cost savings for the individual boilers is shown below.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 9,613 | 4,506 | 5,107 | 53 % |
| Energy Usage (mmBtu/yr) | 9,902 | 4,641 | 5,261 | 53 % |
| Fuel Cost | \$33,934 | \$15,907 | \$18,028 | 53 % |

The summary of the cost savings associated with each boiler is as follows:

| Boiler | Existing | Proposed | Energy Savings |
|---|---|---|---|
| No. 1 | $9,731 | $3,893 | $5,839 |
| No. 2 | $6,820 | $4,547 | $2,273 |
| No. 3 | $33,934 | $15,907 | $18,028 |
| No. 5 | $18,872 | $4,718 | $14,154 |
| No. 6 | $5,961 | $3,577 | $2,384 |

**Maintenance Savings.** The annual maintenance cost (-savings) associated with this ECO is $1,000 for Boiler No. 3.

**Discussion.** Payback Period = 4.4 years (Boiler No. 3 only)

Savings to Investment Ratio = 4.8 (Boiler No. 3 only)

These are the results of the ECOs Life Cycle Analysis for Boiler No. 3 only and a copy of it can be found attached along with LCCID sheets for each of the other boilers and for the five together.

The individual payback for each boiler is shown below.

| Boiler | Cost | Total Savings | Payback |
|---|---|---|---|
| No. 1 | $49,000 | $4,839 | 10 years |
| No. 2 | $49,000 | $1,273 | 39 years |
| No. 3 | $75,000 | $17,028 | 4.4 years |
| No. 5 | $77,000 | $13,154 | 5.8 years |
| No. 6 | $77,000 | $1,384 | 56 years |

A review of this analysis would suggest that the performance and associated payback for Boilers No.1 and No.2, would be closer to each other. The existing efficiencies for Boilers No. 1 and No. 2 are 78.7% and 80.4% respectively. These boilers are the same model and were installed at the same time. It is Entech's opinion that Boiler No. 1 with some adjustments could perform on an efficiency level comparable to Boiler No. 2. If these adjustments are made, the payback for Boiler No. 1 would be closer to 39 years.

The payback period for Boiler No. 3 is 4.4 years, and the SIR is 4.8. It is Entech's recommendation to install $O_2$ trim controls on this boiler. As for Boilers No. 5 and No. 6, the numbers from this study would suggest that Boiler No. 5 have $O_2$ trim controls. The reality is that the stacks on both of these boilers are suspected to be very leaky. These conditions would make $O_2$ control very difficult to achieve. In addition, it's Entech's recommendation to operate these boilers less often in future. Entech does not recommend $O_2$ trim controls for Boiler No. 5 and No. 6.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK2

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080

INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3

PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY

FISCAL YEAR 1995 DISCRETE PORTION NAME: B-5 OXYGEN TRIM CONTROLS (#3)

ANALYSIS DATE: 09-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 67000. | | |
| B. SIOH | $ 4000. | | |
| C. DESIGN COST | $ 4000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 75000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 75000. |

2. ENERGY SAVINGS (+) / COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 5248. | $ 18001. | 20.96 | $ 377293. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 5248. | $ 18001. | | $ 377293. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1000.

(1) DISCOUNT FACTOR (TABLE A) 14.74

(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -14740.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -14740.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 17001.

5. SIMPLE PAYBACK PERIOD (1G/4) 4.41 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 362553.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.83
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 11.55 %

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-5 OXYGEN CONTROLS (#1)
ANALYSIS DATE: 09-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 43000. | |
| B. SIOH | $ 3000. | |
| C. DESIGN COST | $ 3000. | |
| D. TOTAL COST (1A+1B+1C) | $ 49000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 49000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 1702. | $ 5838. | 20.96 | $ 122362. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 1702. | $ 5838. | | $ 122362. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -14740.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -14740.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 4838.

5. SIMPLE PAYBACK PERIOD (1G/4) 10.13 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 107622.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.20
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 7.24 %

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-5 OXYGEN TRIM CONTROLS (#2)
ANALYSIS DATE: 09-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 43000. | | |
| B. SIOH | $ 3000. | | |
| C. DESIGN COST | $ 3000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 49000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 49000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 663. | $ 2274. | 20.96 | $ 47665. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 663. | $ 2274. | | $ 47665. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -14740.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -14740.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 1274.

5. SIMPLE PAYBACK PERIOD (1G/4) 38.46 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 32925.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .67
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 1.07 %

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-5 OXYGEN TRIM CONTROLS (#5)
ANALYSIS DATE: 09-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 69000. | | |
| B. SIOH | $ 4000. | | |
| C. DESIGN COST | $ 4000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 77000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 77000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 1. | $ 7. | 15.61 | $ 110. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 4126. | $ 14152. | 20.96 | $ 296630. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 6. |
| N. TOTAL | | 4127. | $ 14160. | | $ 296745. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -14740.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -14740.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 13160.

5. SIMPLE PAYBACK PERIOD (1G/4) 5.85 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 282005.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 3.66
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 10.01 %

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK2

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080

INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3

PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY

FISCAL YEAR 1995 DISCRETE PORTION NAME: B-5 OXYGEN TRIM CONTROLS (#6)

ANALYSIS DATE: 09-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | | |
|---|---|---|---|---|
| A. CONSTRUCTION COST | $ 69000. | | | |
| B. SIOH | $ 4000. | | | |
| C. DESIGN COST | $ 4000. | | | |
| D. TOTAL COST (1A+1B+1C) | $ 77000. | | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 77000. | |

2. ENERGY SAVINGS (+) / COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 695. | $ 2384. | 20.96 | $ 49965. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 695. | $ 2384. | | $ 49965. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1000.

(1) DISCOUNT FACTOR (TABLE A) 14.74

(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -14740.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -14740.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 1384.

5. SIMPLE PAYBACK PERIOD (1G/4) 55.64 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 35225.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .46
   (IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): -.85 %

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-5 OXYGEN TRIM CONTROLS
ANALYSIS DATE: 07-21-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 293000. | | |
| B. SIOH | $ 16000. | | |
| C. DESIGN COST | $ 18000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 327000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 327000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 12453. | $ 42714. | 20.96 | $ 895281. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 12453. | $ 42714. | | $ 895281. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ -5000.
(1) DISCOUNT FACTOR (TABLE A) — 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ -73700.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -73700.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 37714.

5. SIMPLE PAYBACK PERIOD (1G/4) 8.67 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 821581.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.51
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 7.96 %

## ECO B-6
## AIR PREHEATERS

**Existing.** Boilers No. 1, No. 2, and No. 3 have economizers that recover heat from the existing flue gas to heat boiler feedwater. None of the boilers currently have air preheaters. Air preheaters heat combustion air by recovering heat from boiler flue gas. Preheating the combustion air reduces the energy required to elevate the air to combustion temperatures. This results in improved fuel-to-steam efficiency.

The costs to operate the five boilers include fuel costs and electrical costs to operate the forced draft and induced draft fans. The cost to operate the boilers and fans in 1994 was $3,036,000. Refer to Section 4.0 of the report for more detail about current energy consumption.

| | | |
|---|---|---|
| Natural Gas | = | 656,537 mcf/yr |
| No. 6 Fuel Oil | = | 1,645,571 gal/yr |
| Electric Demand | = | 1,143 kW/yr |
| Electric Usage | = | 710,788 kWh/yr |
| Energy Cost | = | $3,036,000 /yr |

$$\left(656{,}537\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}645{,}571\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) +$$

$$\left(1{,}143\ \frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(710{,}788\ \frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$3{,}036{,}027\ \ use,\ \ \$3{,}036{,}000$$

**Proposed.** The fuel-to-steam efficiency of a boiler is expected to improve about one percent for every 50°F rise in combustion air temperature entering the burner. The efficiency gain is, therefore, dependent on the amount of heat that can be recovered from the flue gas. The following table shows average flue gas temperatures for each boiler and current fuel-to-steam efficiencies. The flue gas temperatures were determined from operating log data included in Attachment 8.5.

**Average flue gas temperatures and fuel-to-steam efficiencies.**

| Boiler No. | Avg Flue Gas Temp (°F) | Gas Efficiency | Oil Efficiency |
|---|---|---|---|
| 1 | 292* | 78.7% | 81.3% |
| 2 | 305* | 80.3% | 83.5% |
| 3 | 371* | 73.5% | 77.3% |
| 5 | 461 | 68.5% | 71.3% |
| 6 | 435 | 76.0% | 79.9% |

* Flue gas temperature after economizer

The condensing temperature of some of the existing flue gases is around 300°F. It is best to keep flue gas temperatures above 300°F to minimize moisture in the stack and resulting corrosion. Air preheaters should not be installed on Boilers No. 1 and No. 2 because the flue gas temperature for these boilers is already near 300°F. The economizer on Boiler No. 3 recovers much of the available heat from the flue gases. This boiler is still a good candidate for an air preheater, however, because it accounts for almost 40% of the boiler plant fuel cost. Boilers No. 5 and No. 6 appear to be good candidates for air preheaters because of their high stack temperatures, although these two boilers are operated the least.

ABB Air Preheater, Inc. of Wellsville, NY was consulted for performance information and costs for preheaters for Boilers No. 3, No. 5, and No. 6. The information they provided is included in Attachment 8.5.

The efficiency gain expected for each boiler is based on the temperature of the air leaving the preheaters.

No. 3 eff. gain = 1.7%

$$(154°F - 70°F)\left(\frac{1\%\ eff}{50°F}\right) = 1.7\%$$

No. 5 eff. gain = 3.9%

$$(264°F - 70°F)\left(\frac{1\%\ eff}{50°F}\right) = 3.9\%$$

No. 6 eff. gain = 3.2%

$$(230°F - 70°F)\left(\frac{1\%\ eff}{50°F}\right) = 3.2\%$$

Installation of air preheaters will also impact electric costs. The forced draft and induced draft fans for Boilers No.3, No. 5, and No. 6 will most likely have to be replaced as part of this project. The fans will operate against a higher static pressure due to the pressure loss through the preheater and additional duct work required. The induced draft fans also will handle a larger volume of air when the flue gas temperature is reduced.

The expected energy costs with preheaters in place on Boilers No. 3, No. 5, and No. 6 are $3,001,900. This assumes that the boilers are operated as they were in 1994.

| | | |
|---|---|---|
| Natural Gas | = | 646,897 mcf/yr |
| No. 6 Fuel Oil | = | 1,603,243 gal/yr |
| Electric Demand | = | 1,921 kW/yr |
| Electric Usage | = | 1,156,150 kWh/yr |
| Energy Cost | = | $3,001,900 /yr |

$$\left(646{,}897\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}603{,}243\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) +$$

$$\left(1{,}921\ \frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(1{,}156{,}150\ \frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$3{,}001{,}887\ use,\ \$3{,}001{,}900$$

**Construction Cost.** To implement this project, the preheaters, replacement forced draft fans, and replacement induced draft fans must be purchased and installed. New duct work will be required to route the air stream and flue gas stream through each preheater. The estimated construction cost for this installation is $1,096,000.

| | |
|---|---|
| Material | $545,000 |
| Labor | 438,000 |
| Design Fee | 59,000 |
| SIOH | 54,000 |
| Total | $1,096,000 |

**Savings.** The annual cost savings resulting from the implementation of this project is expected to be $34,100.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 656,537 | 646,897 | 9,640 | 1.5% |
| No. 6 Fuel Oil (gal/yr) | 1,645,571 | 1,603,243 | 42,328 | 2.6% |
| Electric Demand (kW/yr) | 1,143 | 1,921 | -778 | -68.1% |
| Electric Usage (kWh/yr) | 710,788 | 1,156,150 | -445,362 | -62.7% |
| Energy Usage (mmBtu/yr) | 924,985 | 910,239 | 14,746 | 1.6% |
| Energy Cost | $3,036,000 | $3,001,900 | $34,100 | 1.1% |

**Maintenance Savings.** The annual maintenance cost (-savings) expected with this ECO is $10,000.

**Discussion.** Payback Period = 45 years

Savings to Investment Ratio = 0.60

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

This ECO is not very attractive because of the impact of the air preheaters on the fans. Both the forced draft and induced draft fan for each boiler would have to be replaced. The larger motor required will result increased electric costs which offset some of the fuel savings.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-6 AIR PREHEATERS
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 983000. | |
| B. SIOH | $ 54000. | |
| C. DESIGN COST | $ 59000. | |
| D. TOTAL COST (1A+1B+1C) | $ 1096000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 1096000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | -1520. | $ -10686. | 15.61 | $ -166802. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 6336. | $ 17804. | 19.97 | $ 355549. |
| D. NAT G | $ 3.43 | 9929. | $ 34056. | 20.96 | $ 713824. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ -6979. | 14.74 | $ -102870. |
| N. TOTAL | | 14745. | $ 34196. | | $ 799700. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -10000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -147400.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -147400.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 24196.

5. SIMPLE PAYBACK PERIOD (1G/4) 45.30 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 652300.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .60
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): .46 %

## ECO B-7
## SUPPLY COMBUSTION AIR FROM CEILING

**Existing.** During Entech's visit to the boiler plant on March 21, 1995, Entech examined air temperatures in the boiler plant. Boiler No. 3 was the only boiler operating.

<u>Field Data</u>

| | | |
|---|---|---|
| Temperature at No. 3 forced draft fan inlet | = | 80°F |
| Temperature in vicinity of No. 3 induced draft fan on mezzanine | = | 90°F |
| Outside air temperature | = | 60°F |

Increasing the temperature of the combustion air entering the boiler reduces the energy required to elevate the air to combustion temperature. This results in improved fuel to steam efficiency. For every 50°F rise in combustion air temperature entering the burner, the efficiency is expected to increase 1%.

Boiler No. 3 consumes the most fuel of all the boilers, therefore this boiler provides the best opportunity for a viable ECO. In 1994 Boiler No. 3 including the forced draft and induced draft fans, consumed $1,179,700 worth of fuel and electricity.

| | | |
|---|---|---|
| Natural Gas | = | 176,947 mcf/yr |
| No. 6 Fuel Oil | = | 1,288,293 gal/yr |
| Electric Demand | = | 582 kW/yr |
| Electric Usage | = | 367,032 kWh/yr |
| Energy Cost | = | $1,179,700 /yr |

$$\left(176{,}947\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}288{,}293\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) +$$

$$\left(582\ \frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(367{,}032\ \frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$1{,}179{,}735\ \textit{use},\ \$1{,}179{,}700$$

**Proposed.** Install duct to transport the warm ceiling air to the inlet box of a new forced draft fan located at ground level.

The induced draft fan is located about half way between the forced draft fan and the ceiling of the boiler plant. We have assumed that another 10°F of temperature distance between the floor and ceiling for a total of 20°F.

Available efficiency gain = 0.4%

$$(\ 100°F\ -\ 80°F\ )\left(\frac{1\%\ eff}{50°F}\right) = 0.4\%$$

Warm air is less dense than cool air. The forced draft fan will need to move a larger volume of the warm air into the boiler to get the same air to fuel mix needed for effective combustion. This will result in increased fan operating costs over the course of a year. A new fan is required because of limitations of the existing fan and motor, and the undersirable geometry of the doulbe inlet fan. A new single inlet fan with a system volume of 33,000 cfm at 8 in. w.g. equates to a 63 BHP motor requirement. The fan's motor would be selected at 75 HP.

Natural Gas = 175,989 mcf/yr

$$\left(176{,}947\ \frac{mcf}{yr}\right)\left(\frac{73.5\%}{73.5\% + 0.4\%}\right) = 175{,}989\ \frac{mcf}{yr}$$

No. 6 Fuel Oil = 1,281,661 gal/yr

$$\left(1{,}288{,}293\ \frac{gal}{yr}\right)\left(\frac{77.3\%}{77.3\% + 0.4\%}\right) = 1{,}282{,}661\ \frac{gal}{yr}$$

Electric Demand = 679 kW/yr

Electric Usage = 425,310 kWh/yr

Energy Cost = $1,175,800 /yr

$$\left(175{,}989\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}281{,}661\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) +$$

$$\left(679\ \frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(425{,}310\ \frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$1{,}175{,}837\ \textit{use},\ \$1{,}175{,}800$$

**Construction Cost.** The estimated construction cost for this installation is $58,000.

| | |
|---|---|
| Material | $24,000 |
| Labor | 28,000 |
| Design Fee | 3,000 |
| SIOH | 3,000 |
| Total | $58,000 |

**Savings.** The annual cost savings resulting from the implementation of this project are expected to be $3,900.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 176,947 | 175,989 | 958 | 0.5% |
| No. 6 Fuel Oil (gal/yr) | 1,288,293 | 1,281,661 | 6,632 | 0.5% |
| Electric Demand (kW/yr) | 582 | 679 | -97 | -16.7% |
| Electric Usage (kWh/yr) | 367,032 | 425,310 | -58,278 | -15.9% |
| Energy Usage (mmBtu/yr) | 376,353 | 374,572 | 1,781 | 0.5% |
| Energy Cost | $1,179,700 | $1,175,800 | $3,900 | 0.3% |

**Maintenance Savings.** The annual maintenance cost (-savings) expected with this ECO is $500.

**Discussion.** Payback Period = 17 years

Savings to Investment Ratio = 1.5

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-7 SUPPLY COMB. AIR FROM CEILIN
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT
A. CONSTRUCTION COST $ 52000.
B. SIOH $ 3000.
C. DESIGN COST $ 3000.
D. TOTAL COST (1A+1B+1C) $ 58000.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 58000.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | -199. | $ -1399. | 15.61 | $ -21838. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 993. | $ 2790. | 19.97 | $ 55723. |
| D. NAT G | $ 3.43 | 987. | $ 3385. | 20.96 | $ 70958. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ -870. | 14.74 | $ -12824. |
| N. TOTAL | | 1781. | $ 3907. | | $ 92019. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -500.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -7370.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -7370.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 3407.

5. SIMPLE PAYBACK PERIOD (1G/4) 17.02 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 84649.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.46
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 5.07 %

## ECO B-8
## UPDATE INSTRUMENTS & CONTROLS

**Existing.** The Boiler Plant operates with relatively new controls. Seven years ago, in 1988, controls for Boilers 3, 5, and 6 were integrated into a new Westinghouse 1500 system. Separate controls were included as part of a package installation with the two new Boilers, 1 and 2 in 1991. Discussions with operators reflect minimal problems associated with the present instruments and controls.

**Proposed.** Make improvements to existing instruments and controls in order to reduce operating costs. NOTE: Individual ECOs in this report address automatic blowdown control, $O_2$ trim control, and steam and condensate metering.

**Construction Cost.** There is no construction cost associated with this energy conservation opportunity.

**Savings.** None.

**Discussion.** It is Entech's position that changes to existing instruments and controls is not recommended based on energy savings.

# ECO B-9
# NEW STEAM METERING

**Existing:** Presently Fort Detrick utilizes square faced orifice plates for determining the steam output from each of the five boilers. The line pressure of the header downstream of the orifice plates is generally around 112 psig. On Boiler No. 3 at relatively high flows (i.e.: greater than 100,000 lb/hr) the drum pressure in the boiler is approximately 124 psig (±). This equates to a combined differential pressure of 12 psig (±) through the stop valve, the shutoff gate valve, 15 feet of piping, and the orifice plate. Data was collected on valves and orifice plates for Boilers No. 3 and No. 5. Pressure drops were determined for each line at a flow rate of 75% of the boiler's capacity. The pressure drops through the two lines are summarized in the table below. Baseline calculations and reference information is attached.

**Pressure Drop - Results for Lines 3 and 5**

| Boiler | Line Size | Stop Valve | Flow (lb/hr) | Pressure Drop (psig) | | | | Est.Drum Pressure (psig) |
|---|---|---|---|---|---|---|---|---|
| | | | | Stop Valve | Shutoff & Pipe | Orifice Plate | Total | |
| 3 | 12" | 10" | 97,500 | 5.0 | 1.0 | 4.6 | 10.6 | 122.6 |
| 5 | 10" | 10" | 49,500 | 2.0 | 0.5 | 3.4 | 5.9 | 117.9 |

An aggressive approach will be used to determine the costs associated with maintaining drum pressure above the line pressure of 112 psig. A pressure drop of 10 psig will be used in conjunction with the sites average flow rate of 78,900 lb/hr. The orifice will account for 4 psig, and the remainder will be accounted for in the stop valve, the shutoff valve and the piping. From steam tables, it was determined that the equivalent Btu/lbm/psig in this pressure/temperature range is 0.13 Btu/lbm/psig. With this the estimated cost to maintain adequate drum pressure using natural gas is $3,100.

Steam Produced = 78,900 lb/hr (yearly average)

Energy Demand = 900 mmBtu
(adequate drum P)

$$\left(78{,}900\frac{lb}{hr}\ x\ 8{,}760\frac{hr}{yr}\ x\ 0.13\frac{\frac{Btu}{lb}}{psig}\ x\ 10\ psig\right) = 898\ mmBtu,\ use\ 900\ mmBtu$$

Natural Gas = 874 mcf

$$\left(900\ mmBtu\ x\ \frac{1\ mcf}{1.03\ mmBtu}\right) = 874\ mcf$$

Fuel Cost = $3,100

$$\left(874\ mcf\ x\ \frac{\$3.53}{mcf}\right) = \$3{,}084,\ use\ \$3{,}100$$

**Proposed:** Utilize annubar type steam meters on all boiler discharge lines in place of the existing orifice meters in an attempt to reduce drum pressure, and ultimately, fuel costs. Annubar type flow meters are known for their accuracy, and the fact that the pressure drop through them is significantly lower than orifice type meters. The pressure drop for flows calculated for lines 3 and 5 would be in the range of 1.3 psig. For calculation purposes, relative to the 4 psig drop assigned to the orifice plates, 1 psig will be used for estimating the cost savings. The flow remains the same and subsequently the pressure drop through the stop valve, shutoff valve and piping remains the same. Therefore the required pressure in the boiler drums will be 3 psig less or ~~119 psig~~. The differential to the line pressure then becomes 7 psig. The costs to maintain drum pressure above the desired line pressure now becomes $2,150.

Steam Produced = 78,900 lb/hr (yearly average)

Energy Demand = 630 mmBtu
(adequate drum P)

124 − 3 = 121

$$\left(78{,}900\frac{lb}{hr} \ x \ 8{,}760\frac{hr}{yr} \ x \ \$0.13\frac{\frac{Btu}{lb}}{psig} \ x \ 7 \ psig\right) = 629 \ mmBtu, \ use \ 630 \ mmBtu$$

Natural Gas = 611 mmBtu

$$\left(629 \ mmBtu \ x \ \frac{1 \ mcf}{1.03 \ mmBtu}\right) = 611 \ mcf$$

Fuel Cost = $2,150

$$\left(611 \ mcf \ x \ \frac{\$3.53}{mcf}\right) = \$2{,}156, \ use \ \$2{,}150$$

**Construction Cost.** The expected construction cost for the project will be $54,000. Reference the cost estimate attached.

| | |
|---|---|
| Material | $33,000 |
| Labor | 15,000 |
| Design Fee | 3,000 |
| SIOH | 3,000 |
| | $54,000 |

**Savings.** The annual cost savings resulting from the implementation of this project will be $950 ($3,100 - $2,150).

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Steam Produced (lb/hr) | 78,900(av) | 78,900(av) | 0 | 0% |
| Natural Gas (mcf/yr) | 874 | 611 | 263 | 30% |
| Energy Usage (mmBtu) | 900 | 630 | 270 | 30% |
| Fuel Cost | $3,100 | $2,150 | $950 | 30% |

**Maintenance Savings.** The operation and maintenance cost (-savings) expected with this ECO will be about (-$1,000) per year.

**Discussion.** Payback Period = $\infty$

Savings to Investment Ratio = 0.09

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

Without the added maintenance cost the payback would be over 50 years.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: B-9 NEW STEAM METERING
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 48000. | |
| B. SIOH | $ 3000. | |
| C. DESIGN COST | $ 3000. | |
| D. TOTAL COST (1A+1B+1C) | $ 54000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 54000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 271. | $ 930. | 20.96 | $ 19483. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 271. | $ 930. | | $ 19483. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -14740.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -14740.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ -70.

5. SIMPLE PAYBACK PERIOD (1G/4) ****** YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 4743.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .09
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): -8.71 %

## 6.4 (O) Operation

The following section contains the evaluations for the ECOs investigating the Operation of the Boiler Plant. They are ECOs O-1 through O-6.

O-1 Shut off Standby Boilers
O-2 Improve Boiler Sequencing
O-3 Summer Shutdown of Boiler Plant
O-4 Replace Less Efficient Boilers
O-5 Fuel Usage Election Plan
O-6 Alternate Fuels (Natural Gas Brokering)

## ECO O-1
## SHUT OFF STANDBY BOILERS

**Existing.** The Boiler Plant operation logs show that boilers are kept in hot standby condition when not in use. This is done so additional boilers can begin making steam quickly in the event a boiler malfunctions or steam requirements suddenly increase. The boilers consume fuel in order to maintain temperature but they do not produce steam when in hot standby.

Operation logs show that in 1994, all unused boilers were kept in hot standby in January, February, March, November, and December. Typically, one of the unused boilers was shut down completely for about half of the month during the remaining, milder months. The boilers consume gas when in hot standby unless Frederick Gas has interrupted service. The amount of gas consumed by each boiler on a daily basis when in hot standby was estimated from Boiler Plant operation logs.

**Estimated Fuel Use in Hot Standby**

| Boiler No. | Gas Usage (mcf/day) |
|---|---|
| 1 | 7.1 |
| 2 | 7.7 |
| 3 | 32.4 |
| 5 | 17.8 |
| 6 | 18.4 |

Approximately \$59,000 was spent in 1994 for fuel consumed by boilers kept in hot standby condition. This is 2% (\$59,000 ÷ \$3,008,700 x 100) of the total cost for fuel at the Boiler Plant. An analysis of the amount of fuel used for banking the boilers is included in Section 4.0 of this report.

Natural Gas = 15,924 mcf/yr

No. 6 Fuel Oil = 6,711 gal/yr

Fuel Cost = $59,000 /yr

$$\left(15{,}924\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(6{,}711\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$59{,}030\ \ use,\ \$59{,}000$$

**Proposed.** Shut down either Boiler No. 5 or Boiler No. 6 completely for the entire year. The other boiler should be kept in hot standby condition. Shut down Boiler No. 3 between April and September, Figure ECO O-1 shows that even if the largest available boiler experiences mechanical problems, the steam load can be met with the remaining boilers.

The annual energy cost associated with keeping one boiler in hot standby condition is estimated to be $21,300.

Natural Gas = 5,249 mcf/yr

No. 6 Fuel Oil = 6,711 gal/yr

Energy Cost = $21,300 /yr

$$\left(5{,}249\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(6{,}711\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$21{,}348\ \ use,\ \$21{,}300$$

**Construction Cost.** The construction cost associated with this energy conservation opportunity for implementation purposes is $5,000 total. It requires a change in operating practices only.

why $5000 to change practices?

# Analysis of Boiler Requirements

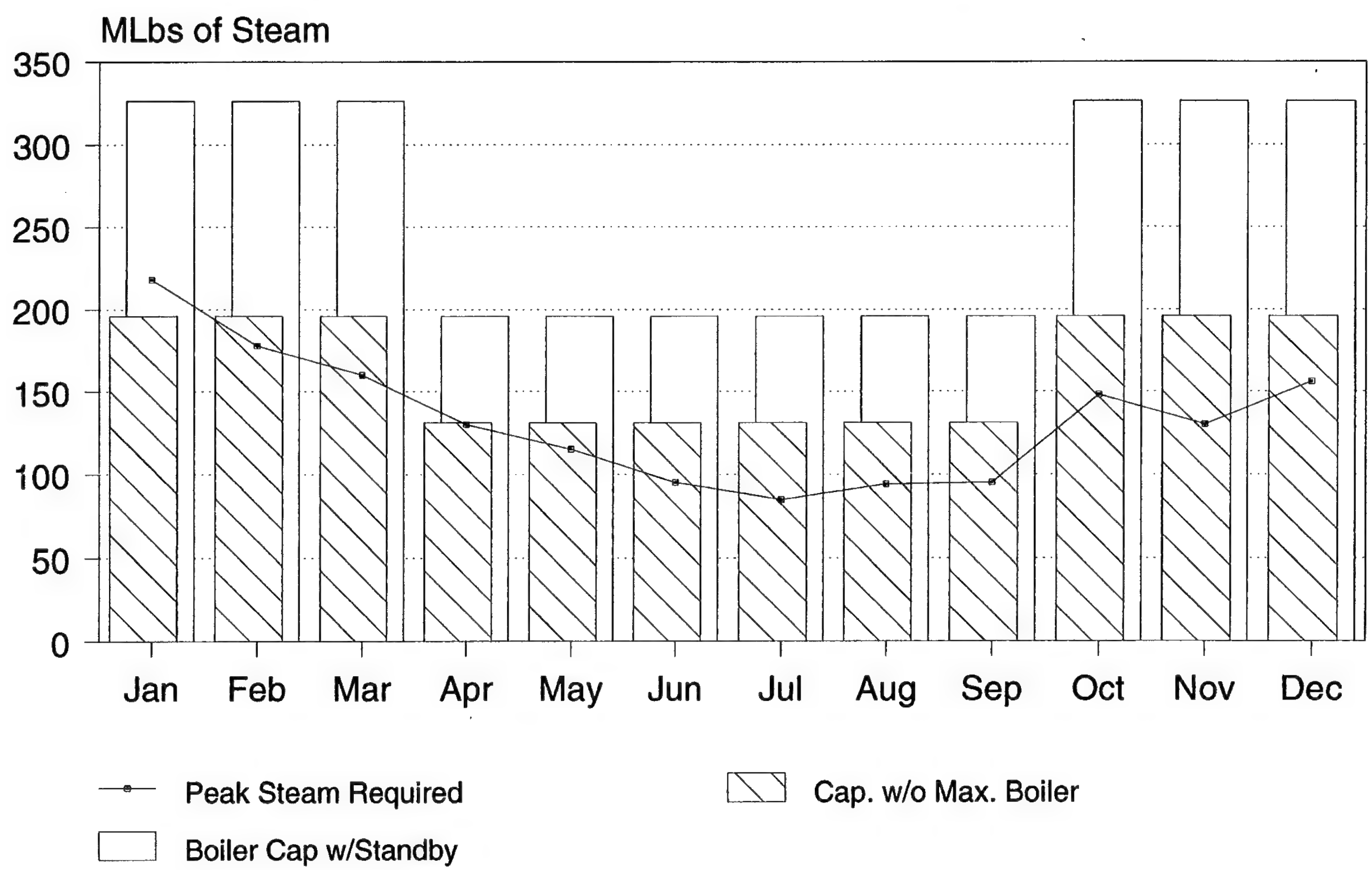


Figure ECO O-1

**Savings.** The annual cost savings resulting from the implementation of this project will be $36,600.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 15,924 | 5,249 | 10,675 | 67% |
| No. 6 Fuel Oil (gal/yr) | 6,711 | 6,711 | 0 | 0% |
| Energy Usage (mmBtu/yr) | 17,406 | 6,411 | 10,995 | 63% |
| Energy Cost | $59,000 | $21,300 | $37,700 | 64% |

**Maintenance Savings.** The maintenance and operation savings associated with this ECO is $0.

**Discussion.** Payback Period = 0.13 years

Savings to Investment Ratio = 158

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

The Boiler Plant currently has the capacity to produce 392,000 lb/yr of steam. The peak demand for steam measured at the Boiler Plant in 1994 was 218,000 lb/yr. This peak occurred on January 19, 1994, a day when the record for cold temperature was broken in many areas. The peak demand for steam in 1993 was measured to be 187,000 lb/hr. Our analysis of the boiler operations logs show that the number of boilers kept in hot standby condition can be reduced without jeopardizing the plant's ability to meet steam loads. An estimated $37,700 and 10,677 mcf/yr can be saved if the operating strategy described above is implemented.

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with WCl

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: O-1 SHUT OFF STANDBY BOILERS
ANALYSIS DATE: 07-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 5000. | |
| B. SIOH | $ 0. | |
| C. DESIGN COST | $ 0. | |
| D. TOTAL COST (1A+1B+1C) | $ 5000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 5000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 10995. | $ 37713. | 20.96 | $ 790461. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 10995. | $ 37713. | | $ 790461. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 37713.

5. SIMPLE PAYBACK PERIOD (1G/4) .13 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 790461.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 158.09
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 32.80 %

## ECO O-2
## IMPROVE BOILER SEQUENCING

**Existing.** There is currently no strategic plan for operating the Boilers. In general, Boilers No. 1 and No. 2 are used frequently during the summer and Boiler No. 3 is base loaded in the winter time. Refer to Figure 4.4.1 for a graphical summary of how much steam is produced by each boiler monthly. The 1994 cost for fuel consumed by the boilers to make steam was $2,950,000. This figure does not include fuel consumed for banking the boilers. Refer to Section 4.0 for more detail about the fuel consumed by each boiler.

Natural Gas = 640,613 mcf/yr

No. 6 Fuel Oil = 1,638,860 gal/yr

Fuel Cost = $2,950,000

$$\left(640{,}913\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}638{,}860\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}950{,}744\ \ use,\ \$2{,}950{,}000$$

**Proposed.** Use Boilers No. 1 and No. 2 as much as possible because these boilers have the best efficiencies. Refer to Section 5.12 of this report for the efficiency analysis. Boiler No. 1 can be base loaded in the summer. Since Boilers No. 1 or No. 2 can not meet load in the winter, Boiler No. 3 should be base loaded during the heating season. Boiler No. 2 can follow the fluctuating load throughout the year.

**Boiler Efficiencies**

| Boiler No. | Gas Efficiency | Oil Efficiency |
|---|---|---|
| 1 | 78.7% | 81.3% |
| 2 | 80.3% | 83.5% |
| 3 | 73.5% | 77.3% |
| 5 | 68.5% | 71.3% |
| 6 | 76.0% | 79.9% |

The following table shows the number of days in each month that the peak boiler plant load was between zero and 65,000 lb/hr indicating that one boiler can satisfy the load, the number of days the peak load was between 65,000 lb/hr and 130,000 lb/hr indicating that two boilers or Boiler No. 3 can satisfy the load, and the number of days the peak load was between 130,000 lb/hr and 195,000 lb/hr. This data was collected from the boiler plant operating logs.

**Peak Steam Requirements**
**Number of Days**

| 1994 | Day/Month | 0-65 mlb/hr | 65-130 mlb/hr | 130-195 mlb/hr |
|---|---|---|---|---|
| Jan | 31 | 0 | 3 | 28 |
| Feb | 28 | 0 | 6 | 22 |
| Mar | 31 | 0 | 18 | 13 |
| Apr | 30 | 0 | 30 | 0 |
| May | 31 | 0 | 31 | 0 |
| Jun | 30 | 7 | 23 | 0 |
| Jul | 31 | 10 | 21 | 0 |
| Aug | 31 | 4 | 27 | 0 |
| Sep | 30 | 1 | 29 | 0 |
| Oct | 31 | 0 | 28 | 3 |
| Nov | 30 | 0 | 30 | 0 |
| Dec | 31 | 0 | 15 | 16 |

The peak load from April to September lies between 65,000 lb/hr and 130,000 lb/hr 88% of the time. Therefore, two boilers are necessary to meet the load during most of the summer. For the purpose of this analysis, we have assumed that Boiler No. 1 is base loaded at 75% of its capacity, or 48,750 lb/hr, and Boiler No. 2 follows the fluctuating load.

Boiler No. 3 is the largest boiler and is suitable for use during the winter, when the steam demand is the greatest. Between October and March, a boiler is needed to supplement No. 3 45% of the time. For the purpose of estimating available savings, we assumed that Boiler No. 3 is operated at 75% load on days when a second boiler is needed and at 50% load when the peak load is below 130,000 lb/hr. Please note that only daily peaks were recorded in the operating logs. The average hourly load is much lower.

Figure ECO O-2 graphically shows how much steam would be produced monthly by each boiler under this strategy.

All of the oil consumed in the winter of 1994 by Boilers No. 1, No. 3, No. 5, and No. 6 is assumed to be consumed by boiler No. 3 under this strategy.

The annual energy cost associated with operating the boilers in this manner is estimated to be $2,909,000.

| | | |
|---|---|---|
| Natural Gas | = | 627,356 mcf/yr |
| No. 6 Fuel Oil | = | 1,654,043 gal/yr |
| Fuel Cost | = | $2,909,000 |

$$\left(627{,}356\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}654{,}043\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}909{,}264\ \ use,\ \$2{,}909{,}000$$

**Construction Cost.** The construction cost associated with this energy conservation opportunity for implementation purposes is $5,000 total. It requires a change in operating practices only.

why does it cost anything?

# Boiler Sequencing Analysis

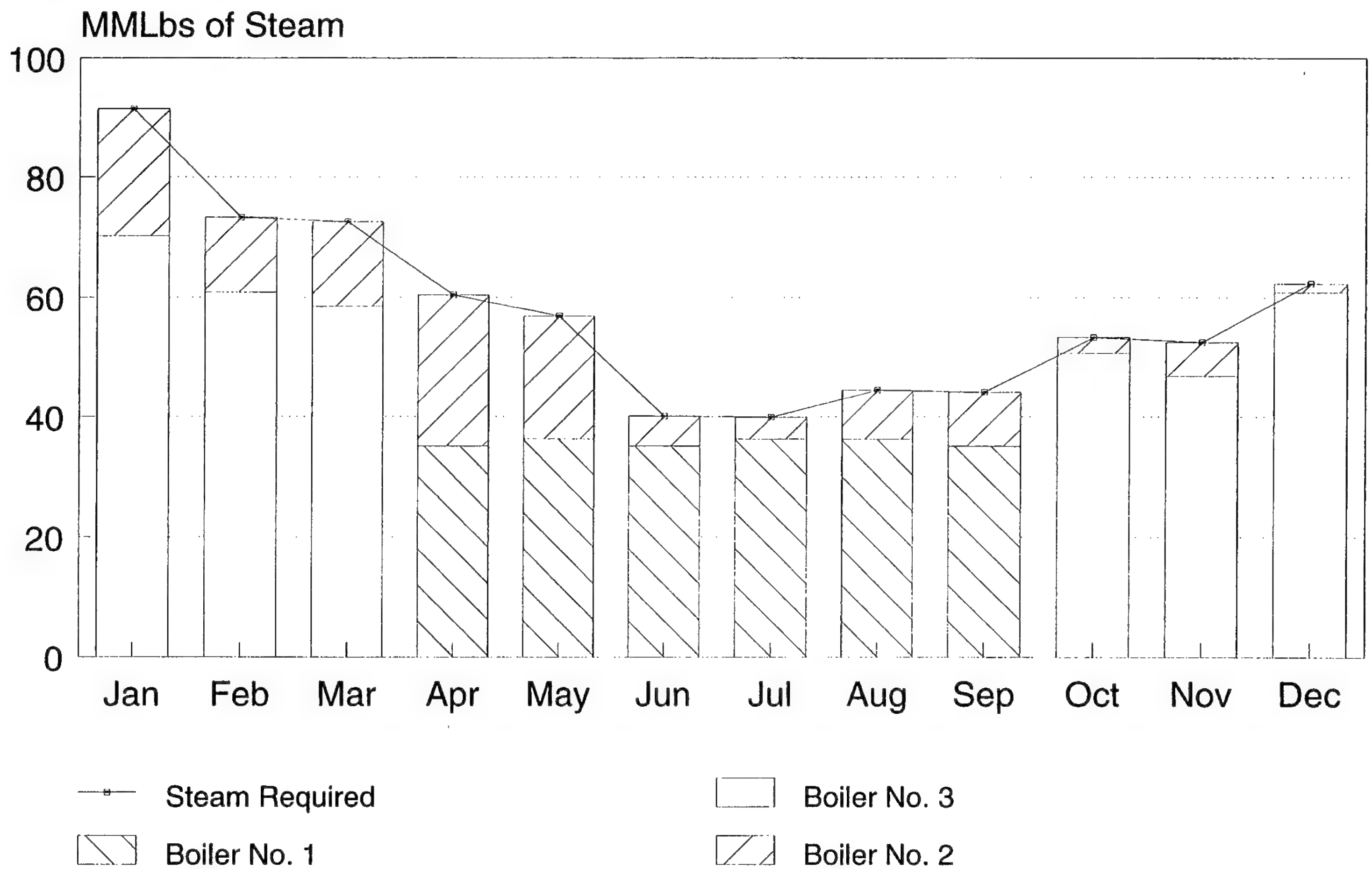



Figure ECO O-2

**Savings.** The annual cost savings resulting from the implementation of this project will be $41,000.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 640,613 | 627,356 | 13,257 | 2% |
| No. 6 Fuel Oil (gal/yr) | 1,638,860 | 1,654,043 | -15,183 | -1% |
| Energy Usage (mmBtu/yr) | 905,152 | 893,770 | 11,382 | 1% |
| Fuel Cost | $2,950,000 | $2,909,000 | $41,000 | 1% |

**Maintenance Savings.** The maintenance and operation savings associated with this ECO is $0.

**Discussion.** Payback Period = 0.12 years

Savings to Investment Ratio = 171

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

Operation of Boilers No. 5 and No. 6 is not required to meet the steam requirements observed at the boiler plant. These boilers are less efficient and about 35 years older than Boilers No. 1 and No. 2. Approximately $41,000 can be saved by utilizing Boilers No. 1, No. 2, and No. 3 to their fullest extent. Banking of Boilers No. 5 and/or No. 6 will still be required to ensure adequate backup capacity in the event of a boiler failure.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: O-2 IMPROVE BOILER SEQUENCING
ANALYSIS DATE: 07-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 5000. | |
| B. SIOH | $ 0. | |
| C. DESIGN COST | $ 0. | |
| D. TOTAL COST (1A+1B+1C) | $ 5000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 5000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | -2273. | $ -6387. | 19.97 | $ -127551. |
| D. NAT G | $ 3.43 | 13655. | $ 46837. | 20.96 | $ 981696. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 11382. | $ 40450. | | $ 854145. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 40450.

5. SIMPLE PAYBACK PERIOD (1G/4) .12 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 854145.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 170.83
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 33.32 %

## ECO O-3
## SUMMER SHUTDOWN OF BOILER PLANT

**Existing.** Fort Detrick operates the boiler plant during the summer to provide steam to the base. Steam requirements are significantly lower during the summer than the rest of the year. In 1994, the peak steam load recorded during the summer was 95,000 lb/hr. The peak steam load recorded that year was 218,000 lb/hr in January.

Steam loads unique to the winter, spring, and fall seasons are space heating and humidification. Steam use in the summer is limited to loads with year round requirements such as reheats, domestic hot water, autoclaves and cage washers, sewage decontamination, and process. In 1994, 168,567,000 lbs of steam was produced between June and September to satisfy these summer time steam needs. Table 5.11.2 includes information about monthly steam use.

The cost to operate the boiler plant in the summer is estimated to be $784,300. This figure includes cost to produce steam and to operate fans, pumps, lighting, etc. Please refer to the Electric Model, Table 5.14.1, for more information about electric use at the boiler plant.

| | | |
|---|---|---|
| Steam Produced | = | 168,567 mlbs/summer |
| Natural Gas | = | 218,269 mcf/summer |
| No. 6 Fuel Oil | = | 524 gal/summer |
| Electric Demand | = | 592 kW/summer |
| Electric Usage | = | 346,176 kWh/summer |
| Energy Cost | = | $784,300 |

$$\left(218{,}269\frac{mcf}{summer} \times \frac{\$3.53}{mcf}\right) + \left(524\frac{gal}{summer} \times \frac{\$0.42}{gal}\right) + \left(592\frac{kW}{summer} \times \frac{\$8.97}{kW}\right) + \left(346{,}176\frac{kWh}{summer} \times \frac{\$0.024}{kWh}\right) = \$784{,}328\ \textit{use},\ \$784{,}300$$

**Proposed.** The boiler plant can be shut down during the summer months. Summer shut down saves energy because losses in the steam distribution lines are eliminated. Summer shut down also provides an opportunity to catch up on boiler plant equipment maintenance and steam and condensate line repairs.

The 46 buildings that use steam during the summer are located at various points on the base. Equipment would need to be installed at each building with summer steam requirements. For this analysis, we have assumed that electric hot water heaters would be installed in the buildings that use steam only for domestic hot water in the summer. Many of the buildings that use steam in the summer are operated by the National Cancer Institute. This portion of the site does not presently have gas service. We have assumed that buildings with steam needs requiring a boiler smaller than 50 BHP will be equipped with an electric instantaneous steam boiler. The remaining buildings would require a No. 2 oil-fired boiler plant. The fuel oil would be stored in a tank at the building. Please refer to Attachment 8.5 for more detail about the assumptions made for this analysis.

The following list is a tally of the equipment that is expected to be required for implementation of this ECO.

**Expected Equipment**

| No. Units | Equipment | Location |
|---|---|---|
| 18 | Hot Water Heaters | Ref. Att.8.5 |
| 16 | Instantaneous Boilers | Ref. Att. 8.5 |
| 2 | 350 BHP Boiler Plants | 1425, 375 |
| 2 | 250 BHP Boiler Plants | 560, 539 |
| 3 | 150 BHP Boiler Plants | 1412,1022-1049, 376 |
| 5 | 100 BHP Boiler Plants | 538, 1301, 469, 571, 567 |

Assuming steam and hot water consumption levels consistent with those observed in 1994, the energy cost to operate this equipment for a summer and to operate the lighting, hot water heater, and air conditioners at the boiler plant is estimated to be $798,000.

| | | |
|---|---|---|
| Steam Produced | = | 118,500 mlb/hr |

$$\left(109{,}723\ \frac{mlb}{hr}\ x\ 1.08\ (Losses)\right) = 118{,}500\ \frac{mlb}{hr}$$

| | | |
|---|---|---|
| Electric Demand | = | 11,762 kW/summer |
| Electric Usage | = | 5,402,200 kWh/summer |
| Natural Gas | = | 0 |
| No. 6 Fuel Oil | = | 0 |
| No. 2 Fuel Oil | = | 953,900 gal/summer |
| Energy Cost | = | $798,000 |

$$\left(11{,}762\ \frac{kW}{summer}\ x\ \frac{\$8.97}{kW}\right) + \left(5{,}402{,}200\ \frac{kWh}{summer}\ x\ \frac{\$0.024}{kW}\right) + \left(953{,}900\ \frac{gal}{summer}\ x\ \frac{0.59}{gal}\right) = \$797{,}960\ use,\ \$798{,}000$$

The cost for No. 2 fuel oil of $0.59 /gal was provided by Fort Detrick.

**Construction Cost.**

The estimated cost to install the hot water heaters, instantaneous boilers, and boiler plants needed to implement this ECO is $4,058,000.

| | |
|---|---|
| Material | $2,198,900 |
| Labor | 1,441,100 |
| Design Fee | 218,000 |
| SIOH | 200,000 |
| Total | $4,058,000 |

It was assumed that two boilers sized for 60% of the maximum steam load will be installed in each of the boiler plants. Diked aboveground tanks sized for a 30 day supply of No. 2 oil were assumed for each of the boiler plant locations.

**Savings.** Their are negative annual energy cost savings resulting from the implementation of this project.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Steam Produced (mlbs/summer) | 168,567 | 118,500 | 50,067 | 29.7% |
| Natural Gas (mcf/summer) | 218,269 | 0 | 218,269 | 100% |
| No. 6 Fuel Oil (gal/summer) | 524 | 0 | 524 | 100% |
| No. 2 Fuel Oil (gal/summer) | 0 | 953,900 | -953,900 | -100% |
| Electric Demand (kW/summer) | 592 | 11,762 | -11,170 | -1,887% |
| Electric Usage (kWh/summer) | 346,176 | 5,402,200 | -5,056,024 | -1,460% |
| Energy Usage (mmBtu/summer) | 226,077 | 151,688 | 74,389 | 32.9% |
| Energy Cost | $784,300 | $798,000 | $-13,500 | -1.7% |

**Maintenance Savings.** The maintenance and operation cost associated with this ECO are ($25,000) /yr. The shutdown and start-up of the plant, in addition to the upkeep, start-up and shutdown of the new equipment adds to the present situation.

**Discussion.** Payback Period = ∞

Savings to Investment Ratio = 0.63

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

While the steam generated and the energy used is reduced, the applicable energy costs are slightly higher than the original costs.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080

INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: O-3 SUMMER SHUTDOWN OF BOILER PL
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 3640000. | |
| B. SIOH | $ 200000. | |
| C. DESIGN COST | $ 218000. | |
| D. TOTAL COST (1A+1B+1C) | $ 4058000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 4058000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | -17259. | $ -121331. | 15.61 | $ -1893973. |
| B. DIST | $ 4.25 | ******* | $ -562258. | 17.56 | $ -9873250. |
| C. RESID | $ 2.81 | -78. | $ -219. | 19.97 | $ -4377. |
| D. NAT G | $ 3.43 | 224817. | $ 771122. | 20.96 | $ 16162720. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ -100195. | 14.74 | $ -1476874. |
| N. TOTAL | | 75184. | $ -12881. | | $ 2914249. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -25000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -368500.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -368500.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ -37881.

5. SIMPLE PAYBACK PERIOD (1G/4) ****** YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 2545749.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .63
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): .72 %

# ECO O-4
# REPLACE LESS EFFICIENT BOILERS

**Existing.** The median life of a steam producing steel watertube boiler is 30 years according to a 1978 survey conducted by American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE). Boilers No. 5 and No. 6 are about 10 years beyond this life expectancy. These boilers also have poor fuel to steam efficiencies compared to the newer boilers in the plant. Refer to Section 5.12 for more detail about boiler efficiencies.

Boiler Capacity, Efficiency and Age

| Boiler No. | Capacity lb/hr | Gas eff. | Oil eff. | Year Installed |
|---|---|---|---|---|
| 1 | 65,000 | 78.7% | 81.3% | 1991 |
| 2 | 65,000 | 80.3% | 83.5% | 1991 |
| 3 | 130,000 | 73.5% | 77.3% | 1966 |
| 5 | 66,000 | 68.5% | 71.3% | 1953 |
| 6 | 66,000 | 76.0% | 79.9% | 1956 |

What about #3

six is better

In 1994, $2,949,700 was spent for fuel used to produce steam. This figure does not include fuel consumed for banking the boilers. Refer to Section 4.0 for detail about these figures.

Natural Gas = 640,613 mcf/yr

No. 6 Fuel Oil = 1,633,860 gal/yr

Fuel Cost = $2,949,700/yr

$$\left(640{,}613\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}633{,}860\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}949{,}685\ \textit{use}\ \$2{,}949{,}700$$

**Proposed.** Replace Boilers No. 5 and No. 6 with new packaged watertube boiler equipped with economizers. For this analysis, we have assumed that the new boilers will have 66,000 lb/hr capacity, the same capacity as the existing boilers. We have also assumed that the new boilers will be operated as much as possible to take advantage of the high efficiency.

According to technical data provided by Cleaver Brooks, a new watertube boiler in this size range equipped with an economizer is expected to be 84% efficient when burning natural gas and 87% efficient when burning No. 6 fuel oil. These efficiencies are observed when the boiler is held at a constant firing rate, not under normal operating conditions. We have assumed for this analysis that the new boilers will operate at the average efficiencies of Boilers No. 1 and No. 2. Boilers No. 1 and No. 2 do have economizers, they were installed only four years ago, and they should be very similar to the proposed new boilers. The assumed efficiencies for the new boilers are, therefore, 79.5% efficient when burning gas and 82.4% efficient when burning oil.

The peak steam load in 1994 was 218,000 lb/hr. This level of steam production occurred for only a few days in January. The peak steam requirement for the rest of the year did not exceed 178,000 lb/hr. Three of the four boilers in the 65,000 lb/hr size range could satisfy the steam load most of the time. The overall plant efficiency would then increase to the efficiency of the newer boilers. See Section 5.12 for existing plant efficiencies.

| | Existing | Proposed |
|---|---|---|
| Plant Gas Efficiency | 76.8% | 79.5% |
| Plant Oil Efficiency | 77.1% | 82.4% |

The expected fuel costs with the new boilers in place and improved plant efficiencies are estimated to be $2,828,600/yr.

Natural Gas = 618,856 mcf/yr

$$640{,}613\ mcf\ x \left(\frac{0.768\ eff}{0.795\ eff}\right) = 618{,}856\ \frac{mcf}{yr}$$

No. 6 Fuel Oil = 1,533, 448 gal/yr

$$1{,}638{,}860\ \frac{gal}{yr}\ x \left(\frac{0.771\ eff}{0.824\ eff}\right) = 1{,}533{,}448\ \frac{gal}{yr}$$

Fuel Cost = $2,828,600/yr

$$\left(618{,}856\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}533{,}448\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}828{,}610\ \ use\ \ \$2{,}828{,}600$$

**Construction Cost.** The estimated cost to remove Boilers No. 5 and No. 6 and replace them with two new 66,000 lb/hr watertube boilers is $1,772,000.

| | |
|---|---|
| Material | $960,000 |
| Labor | 630,000 |
| Design Fee | 95,000 |
| SIOH | 87,000 |
| Total | $1,772,000 |

**Savings.** The annual energy cost savings resulting from the implementation of this project is expected to be $121,000.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 640,613 | 618,856 | 21,757 | 3% |
| No. 6 Fuel Oil (gal/yr) | 1,633,860 | 1,533,448 | 100,412 | 6% |
| Energy Usage (Btu/yr) | 904,404 | 866,964 | 37,440 | 4% |
| Fuel Cost | $2,949,700 | $2,828,600 | $121,100 | 4% |

**Maintenance Savings.** The maintenance and operational savings associated with this ECO is $0.

**Discussion.** Payback Period = 14.9 years

Savings to Investment Ratio = 1.4

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: O-4 REPLACE LESS EFFICIENT BOILE
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 1590000. | |
| B. SIOH | $ 87000. | |
| C. DESIGN COST | $ 95000. | |
| D. TOTAL COST (1A+1B+1C) | $ 1772000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 1772000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 15031. | $ 42237. | 19.97 | $ 843475. |
| D. NAT G | $ 3.43 | 22410. | $ 76866. | 20.96 | $ 1611118. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 37441. | $ 119103. | | $ 2454593. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-) (4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-) (3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 119103.

5. SIMPLE PAYBACK PERIOD (1G/4) 14.88 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 2454593.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.39
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 4.79 %

## ECO O-5
## FUEL USAGE SELECTION PLAN

**Existing.** Fort Detrick purchases natural gas from Frederick Gas under an interruptible rate. Normal operation is to burn natural gas in the boilers. Fort Detrick currently has about 400,000 gallons of No. 6 fuel oil storage in an above ground tank near the boiler plant. Ten (10) 53,000 gallon under ground tanks were recently removed and will be replaced with a 250,000 gallon No. 6 oil above ground tank. The fuel oil is used when gas service has been interrupted. Fort Detrick voluntarily uses the fuel oil during part of the winter to lessen the load on the gas company during their peak season.

Fort Detrick is required to purchase a minimum of 364,078 mcf from Frederick Gas each year according to their agreement.

In 1994, Fort Detrick spent $2,950,000 for fuel consumed in the boiler plant to make steam. This figure does not include fuel consumed for banking the boilers. Refer to Section 4.0 for more detail about the fuel consumed.

Natural Gas = 640,613 mcf/yr

No. 6 Fuel Oil = 1,638,860 gal/yr

Fuel Cost = $2,950,000

$$\left(640{,}613\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}638{,}860\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}949{,}685\ \ use,\ \$2{,}950{,}000$$

We can look at the cost to produce one (1) lb of steam with gas or oil to determine which fuel is more cost effective.

| Fuel | Fuel Heating Value | Unit Cost | Avg. Boiler Eff. |
|---|---|---|---|
| Natural Gas | 1,030,000 Btu/mcf | $3.53/mcf | 76.8% |
| No. 6 Fuel Oil | 149,690 Btu/gal | $0.42/gal | 77.1% |

Unit Gas Cost = \$0.00447/lb

$$\left( \frac{1 \ lb \ steam \ x \ 1{,}003 \ \frac{Btu}{lb}}{0.768 \ eff. \ x \ 1{,}030{,}000 \ \frac{Btu}{mcf}} \right) x \ \frac{\$3.53}{mcf} = \$0.00447/lb$$

Unit Oil Cost = \$0.00365/lb

$$\left( \frac{1 \ lb \ steam \ x \ 1{,}003 \ \frac{Btu}{lb}}{0.771 \ eff. \ x \ 149{,}690 \ \frac{Btu}{gal}} \right) x \ \frac{\$0.42}{gal} = \$0.00365/lb$$

This analysis is not complete, however, unless we consider the additional steam that must be produced when burning oil. No. 6 oil must be heated to pump it and heated and atomized prior to burning. No. 6 oil does not burn as cleanly as natural gas. Steam is used to remove soot buildup from the boiler walls. The percentage of steam produced by oil that must be used at the boiler plant by the oil system was described in Section 5.9.

| | |
|---|---|
| Steam for Fuel Oil Storage | 0.6% |
| Steam for Preheating Fuel Oil | 0.6% |
| Steam for Oil Atomization | 0.7% |
| Steam for Boiler Soot Blowing | 0.4% |
| | 2.3% |

For every pound of steam that leaves the boiler plant for use by Fort Detrick, 0.023 lbs of steam must be produced for internal use by the oil system.

True Unit Oil Cost = \$0.00373/lb

$$\left( \frac{1.023 \ lb \ steam \ x \ 1{,}003 \ \frac{Btu}{lb}}{0.771 \ eff. \ x \ 149{,}690 \ \frac{Btu}{gal}} \right) x \ \frac{\$0.42}{gal} = \$0.00373/lb$$

No. 6 fuel oil is still more economical to burn than natural gas.

**Proposed.** Decrease the amount of steam produced using gas to the 364,078 mcf/yr minimum. Produce the rest of the required steam with No. 6 oil.

The annual fuel cost associated with the proposed operating strategy is $2,735,000.

Natural Gas = 364,078 mcf/yr

No. 6 Fuel Oil = 3,452,663 gal/yr

Fuel Cost = $2,735,000

$$\left(364{,}078\frac{mcf}{yr} \; x \; \frac{\$3.53}{mcf}\right) + \left(3{,}452{,}663\frac{gal}{yr} \; x \; \frac{\$0.42}{gal}\right) = \$2{,}735{,}314 \;\; use, \;\; \$2{,}735{,}000$$

**Construction Cost.** The construction cost associated with this energy conservation opportunity for implementation purposes is $5,000 total. It requires a change in operating practices only.
why does it cost anything

**Savings.** The annual cost savings resulting from the implementation of this project is expected to be $215,000.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 640,613 | 364,078 | 276,535 | 43% |
| No. 6 Fuel Oil (gal/yr) | 1,638,860 | 3,452,663 | -1,813,803 | -111% |
| Energy Usage (mmBtu/yr) | 905,152 | 892,829 | 12,323 | -1.5% |
| Fuel Cost | $2,950,000 | $2,735,000 | $215,000 | 7% |

**Maintenance Savings.** The maintenance and operation savings associated with this ECO are estimated to be (-$10,000) per year. This is due to inherent costs associated with maintaining the fuel oil system burners and tubes.

**Discussion.** Payback Period = 0.02 years

Savings to Investment Ratio = 1,019

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

Increasing the amount of steam produced by No. 6 oil instead of natural gas does not save energy, but it does make economical sense. Fort Detrick will have 650,000 gallons of oil storage capacity upon completion of the ongoing oil tank project. Each tank would need to be filled only six (6) times a year, assuming 75% of the tank's capacity to be usable.

The unknown with this change is the environmental impact it might have with the ever changing regulations.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: 0-5 FUEL USAGE SELECTION PLAN
ANALYSIS DATE: 07-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | | |
|---|---|---|---|---|
| A. CONSTRUCTION COST | $ 5000. | | | |
| B. SIOH | $ 0. | | | |
| C. DESIGN COST | $ 0. | | | |
| D. TOTAL COST (1A+1B+1C) | $ 5000. | | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ | 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ | 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | | $ 5000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | ******* | $ -762937. | 19.97 | $-15235860. |
| D. NAT G | $ 3.43 | 284831. | $ 976970. | 20.96 | $ 20477300. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 13323. | $ 214033. | | $ 5241438. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ -10000. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.74 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ -147400. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -147400.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 204033.

5. SIMPLE PAYBACK PERIOD (1G/4) .02 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 5094038.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1019
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 45.77 %

## ECO O-6
## ALTERNATE FUELS (NATURAL GAS BROKERING)

**Existing.** Presently, the Boiler Plant is provided with natural gas under Frederick Gas's interruptible service rate. This service is available to any customer with dual fuel provided the gas company's facilities and supply are sufficient. The purchase and transportation of gas to the Boiler Plant is provided solely by Frederick Gas. During 1994, the average cost per ccf of gas under this service was $0.353 yielding and total gas cost of $2,146,000. The table below displays monthly gas usage and cost as extracted from Section 4.

| Month | Usage ccf | Therms | Cost $ | $ per Therm | $ per ccf |
|---|---|---|---|---|---|
| January | 188,026 | 191,222 | $73,621 | $0.385 | $0.392 |
| February | 335,274 | 341,644 | $132,832 | $0.389 | $0.396 |
| March | 905,669 | 924,688 | $356,005 | $0.385 | $0.393 |
| April | 664,298 | 676,920 | $240,306 | $0.355 | $0.362 |
| May | 632,761 | 645,416 | $229,123 | $0.355 | $0.362 |
| June | 466,378 | 474,773 | $168,544 | $0.355 | $0.361 |
| July | 436,936 | 445,675 | $158,215 | $0.355 | $0.362 |
| August | 532,612 | 542,732 | $170,960 | $0.315 | $0.321 |
| September | 501,182 | 508,199 | $160,083 | $0.315 | $0.319 |
| October | 600,332 | 611,138 | $192,508 | $0.315 | $0.321 |
| November | 684,370 | 696,689 | $219,457 | $0.315 | $0.321 |
| December | 138,849 | 141,209 | $44,481 | $0.315 | $0.320 |
| Totals | 6,086,687 | 6,200,305 | $2,146,135 | $0.346 | $0.353 |

**Proposed.** Apply for "Delivery Service" within the Interruptible rate schedule. This service is available to any customer who meets the following:

1. Minimum annual consumption requirement of 8,000 mcf.

2. Meets all additional requirements as set forth in the attached rate schedule.

Under this rate structure, for Fort Detrick to purchase gas for one month the following would need to be performed.

1. Nominate gas consumption. This entails determining the quantity of natural gas which is expected to be consumed in the appropriate month.

2. Determine expected mcf per day consumption for the month. This is the total gas consumed in one day for each month and will be utilized in gas balancing.

3. Solicit $/therm city gate quotes from gas brokers and select acceptable provider .

4. Provide gas company with above information.

Once the above have been determined natural gas will be delivered to the site. During the course of a month, the gas company monitors and reports daily gas consumption for the facility. Daily gas reporting is used in balancing. Balancing in simply managing daily deliveries with expected daily consumption. The table below shows the affects of balancing.

| Percent of Imbalance | Imbalance Fee |
|---|---|
| 0 - 3% | No Fee |
| 3 - 10% | 0.7 ¢ per therm |
| 10 - 20% | 1.4 ¢ per therm |
| > 20% | 2.8 ¢ per therm |

Example #1:

| | | |
|---|---|---|
| Expected Daily Usage | = | 100 therms |
| First Day of Gas Usage | = | 120 therms |
| Gas overrun | = | 20 therms (20%, 20 therms ÷ 100 therms) |
| Penalty | = | $0.56 (20 therms x $0.028/therm) |

Example #2:

| | | |
|---|---|---|
| Expected Daily Usage | = | 5,000 therms |
| First Day of Gas Usage | = | 4,700 therms |
| Gas overrun | = | 300 therms (6%, 300 therms ÷ 5,000 therms) |
| Penalty | = | $2.1 (300 therms x $0.007/therm) |

This monitoring and calculation will be performed every day during a month. Whether penalties occur depends upon how well Fort Detrick predicts monthly and daily gas usage. At the end of a month cost adjustments will be made for overruns and excess gas will be billed to the customer under normal interruptible rate schedule.

Under the delivery service Fort Detrick will generally receive two gas bills as opposed to the current one. The following is a breakdown of the bills which would be received.

Gas Broker - Gas cost
Frederick Gas - Transportation and Penalty

The cost for brokered gas is subject to many variables. Market conditions, availability, and size of customer will effect the price. Our recent experience with gas brokering suggest that an average price of $0.225/therm per year could be obtained. In addition, the transportation fee from Frederick can be up to approximately $0.201/therm. This fee will be established by the company and set forth in the service agreement. Entech expects this fee to be approximately $0.10/therm. The combination of the two rates yields an average brokered gas cost of $0.325/therm ($0.225 + $0.10). The table on the following page displays 1994 gas usage with the expected brokered cost.

| Month | Usage ccf | therms | Cost $ | $ per Therm | $ per ccf |
|---|---|---|---|---|---|
| January | 188,026 | 191,222 | $62,147 | $0.325 | $0.331 |
| February | 335,274 | 341,644 | $111,034 | $0.325 | $0.331 |
| March | 905,669 | 924,688 | $300,524 | $0.325 | $0.332 |
| April | 664,298 | 676,920 | $219,999 | $0.325 | $0.331 |
| May | 632,761 | 645,416 | $209,760 | $0.325 | $0.332 |
| June | 466,378 | 474,773 | $154,301 | $0.325 | $0.331 |
| July | 436,936 | 445,675 | $144,844 | $0.325 | $0.332 |
| August | 532,612 | 542,732 | $176,388 | $0.325 | $0.331 |
| September | 501,182 | 508,199 | $165,165 | $0.325 | $0.330 |
| October | 600,332 | 611,138 | $198,620 | $0.325 | $0.331 |
| November | 684,370 | 696,689 | $226,424 | $0.325 | $0.331 |
| December | 138,849 | 141,209 | $45,893 | $0.325 | $0.331 |
| Totals | 6,086,687 | 6,200,305 | $2,015,099 | $0.325 | $0.331 |

**Construction Costs.** The estimated construction cost for the installation of the delivery service rate is $5,000 total. The management of this service will require the services of an individual who is familar with gas rates and procurement. Entech has found most facilities requiring approximately 100 manhours during the first year for training and procurement. Depending upon the individuals position this cost can vary. For the purposes of this ECO, a cost of $50/hr. will be used to yield an annual cost of $5,000.

**Savings.** The potential annual cost savings resulting from the implementation of this project will be $131,000 ($2,146,000 - $2,015,000).

**Maintenance Savings.** The estimated annual maintenance and operation savings associated with this ECO is $0.

**Discussion.** Payback Period = 0.4 years

Savings to Investment Ratio = 549

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

The costs presented in this ECO should not be construed as final. It recommended that Fort Detrick investigate this option more thoroughly with Defense Fuel Supply.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: O-6 ALTERNATE FUELS
ANALYSIS DATE: 07-20-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT
A. CONSTRUCTION COST $ 5000.
B. SIOH $ 0.
C. DESIGN COST $ 0.
D. TOTAL COST (1A+1B+1C) $ 5000.
E. SALVAGE VALUE OF EXISTING EQUIPMENT $ 0.
F. PUBLIC UTILITY COMPANY REBATE $ 0.
G. TOTAL INVESTMENT (1D - 1E - 1F) $ 5000.

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 38192. | $ 131000. | 20.96 | $ 2745760. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 38192. | $ 131000. | | $ 2745760. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 131000.

5. SIMPLE PAYBACK PERIOD (1G/4) .04 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 2745760.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 549.15
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 41.33 %

## 6.5 (S) Site

The following section contains the evaluations for the ECOs investigating the Site (Distribution and Users) opportunities at Fort Detrick. They are ECOs S-1 through S-10.

S-1 Cogeneration
S-2 New Boiler Plant
S-3 Steam Pressure Reduction
S-4 Improve Condensate Return
S-5 Correct Sizing of Traps (Deleted from Scope)
S-6 Steam and Condensate Metering
S-7 Insulate Steam and Condensate Lines
S-8 Replace Steam Humidification Ultrasonic
S-9 Sewage Storage Tank Insulation
S-10 Reduce Contaminated Sewage

# ECO S-1
# COGENERATION

**Existing:** Fort Detrick produces steam continuously through the year at an average rate of approximately 80,000 lb/hr. In Table 4.4.2, July 1994, is found to have the least steam production, with steam production averaging 54,000 lb/hr.

Electrical power is purchased from the utility through a single meter. The average electrical consumption for the year is 14,983 kW. From Table 4.5.1, March 1994, has the smallest average electrical usage at 294,968 kWh/day, or 12,290 kW (294,968/24 hrs/day).

In 1994, $8,443,900 was spent for electricity for the entire base and natural gas and fuel oil consumed at the Boiler Plant.

| | | |
|---|---|---|
| Natural Gas | = | 656,537 mcf/yr |
| No. 6 Fuel Oil | = | 1,645,571 gal/yr |
| Electric Demand | = | 254,742 kW/yr |
| Electric Usage | = | 131,256,000 kWh/yr |
| Energy Cost | = | $8,443,900 |

$$\left(656{,}537\frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}645{,}571\frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) +$$

$$\left(254{,}742\frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(131{,}256{,}000\frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$8{,}443{,}895\ \textit{use},\ \$8{,}443{,}900$$

**Proposed:** Install a cogeneration system to generate electricity for on-site use, and to produce steam with a heat recovery boiler. In order to maximize the economic feasibility of such a project, it is normally best to size the cogeneration system for the electrical and steam baseload requirements. The cogeneration system would run continuously at capacity. Steam and electricity would be produced for on-site use. Export sales are not considered since the prices paid for steam and electricity will be less than "displacement" rates.

It is estimated that the base steam load is below 50,000 lb/hr. The electrical demand is below 12,000 kW. For this analysis a combustion turbine to drive a generator will be considered. The heat from the turbine exhaust is approximately 900-1,000°F, and is directed to a heat recovery boiler to produce steam. The combustion turbine can be fueled on natural gas or fuel oil.

where from

Generally 30% of the energy input to the cogeneration system is converted to electricity, approximately 50% of the energy input can be recovered to product steam, and the remaining 20% is considered losses.

In order to keep within the base load requirements described above, a cogeneration system with the following characteristics is being used in the evaluation.

Allison Gas Turbine Model 501-KBST

| | |
|---|---|
| Rated Electrical Output | 7,290 kW |
| Fuel Consumption | 88.4 mmBtu/hr |
| Fuel Consumption | 85.8 mcf/hr |
| Steam Production | 41,940 lb/hr |

The turbine/generator is approximately 30'x10'x10' and can be installed inside the boiler plant if one of the older boilers is removed. If this space is not available the equipment can be installed in a separate enclosure adjacent to the boiler plant. Piping and electrical connections would have to be extended to the new equipment.

The estimated cost for site electricity and fuel for the Boiler Plant after this ECO is implemented is $7,708,100. This figure includes a penalty of $457,400 for increased maintenance for the cogeneration equipment. We have assumed that oil consumption at the Boiler Plant will remain constant.

| | | |
|---|---|---|
| Natural Gas | = | 918,787 mcf/yr |
| No. 6 Fuel Oil | = | 1,645,571 gal/yr |
| Electric Demand | = | 174,552 kW/yr |
| Electric Usage | = | 72,936,000 kWh/yr |
| Energy Cost | = | $7,708,100 |

$$\left(918{,}787\frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}645{,}571\frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) +$$

$$\left(174{,}552\frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(72{,}936{,}000\frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$7{,}708{,}053\ \ use,\ \$7{,}708{,}100$$

**Construction Cost:** The estimated construction cost for this project is $10,045,000.

| | |
|---|---|
| Material | $6,000,000 |
| Labor | 3,000,000 |
| Design Fee | 550,000 |
| SIOH | 495,000 |
| Total | $10,045,000 |

**Savings:** The estimated savings is approximately $735,800 per year. The attached calculation sheet show the data used in the computer spreadsheet to analyze cogeneration economics. A summary of the savings and costs is as follows:

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 656,537 | 918,787 | -262,250 | -40% |
| No. 6 Fuel Oil (gal/yr) | 1,645,571 | 1,645,571 | 0 | 0% |
| Electric Demand (kW/yr) | 254,742 | 174,552 | 80,190 | 31% |
| Electric Usage (kWh/yr) | 131,256,000 | 72,936,000 | 58,320,000 | 44% |
| Energy Usage (mmBtu/hr) | 1,370,535 | 1,441,607 | -71,072 | -5% |
| Maintenance Cost | 0 | $457,400 | -$457,400 | 0 |
| Energy & Maintenance Cost | $8,443,900 | $7,708,100 | $735,800 | 9% |

**Maintenance Savings.** The annual maintenance cost (-savings) associated with this ECO is $457,000.

**Discussion.** Payback Period = 13.7 years

Savings to Investment Ratio = 0.63

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

This analysis assumes the unit is brought off-line once a year for scheduled maintenance. If unscheduled maintenance occurs in any other month, savings will be reduced.

steam turbine?

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: S-1 CO-GENERATION
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 9000000. | | |
| B. SIOH | $ 495000. | | |
| C. DESIGN COST | $ 540000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 10035000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 10035000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 199046. | $ 1399293. | 15.61 | $ 21842970. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | ******* | $ -926505. | 20.96 | $-19419540. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 719304. | 14.74 | $ 10602540. |
| N. TOTAL | | -71072. | $ 1192093. | | $ 13025970. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -457000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -6736180.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -6736180.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 735093.

5. SIMPLE PAYBACK PERIOD (1G/4) 13.65 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 6289793.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .63
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): .72 %

# ECO S-2
# NEW BOILER PLANT

**Existing.** The median life of a steam producing steel watertube boiler is 30 years according to a 1978 survey conducted by American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE). Boilers No. 5 and No. 6 are about 10 years beyond this life expectancy. These boilers also have poor fuel to steam efficiencies compared to the newest boilers in the plant. Refer to Section 5.12 for more information about boiler efficiencies.

BOILER CAPACITY, EFFICIENCY, AND AGE

| Boiler No. | Capacity lb/hr | Nat. Gas eff. (%) | No. 6 Fuel Oil eff. (%) | Year Installed |
|---|---|---|---|---|
| 1 | 65,000 | 78.7% | 81.3% | 1991 |
| 2 | 65,000 | 80.3% | 83.5% | 1991 |
| 3 | 130,000 | 73.5% | 77.3% | 1966 |
| 5 | 66,000 | 68.5% | 71.3% | 1953 |
| 6 | 66,000 | 76.0% | 79.9% | 1956 |

In 1994, $2,949,700 was spent for fuel used to produce steam. This figure does not include fuel consumed for banking the boilers. Refer to Section 4.0 for detail about these figures.

Natural Gas = 640,613 mcf/yr

No. 6 Fuel Oil = 1,633,860 gal/yr

Fuel Cost = $2,949,700/yr

$$\left(640{,}613\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}633{,}860\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}949{,}685\ \textit{use}\ \$2{,}949{,}700$$

**Proposed.** Fort Detrick has provided information about proposed projects that may impact steam consumption on the base. See Attachment 8.5. The projects scheduled through the year 2002 have a net impact of 414,700 additional square feet. Of this, 390,600 square feet is expected to be served by steam from the central boiler plant.

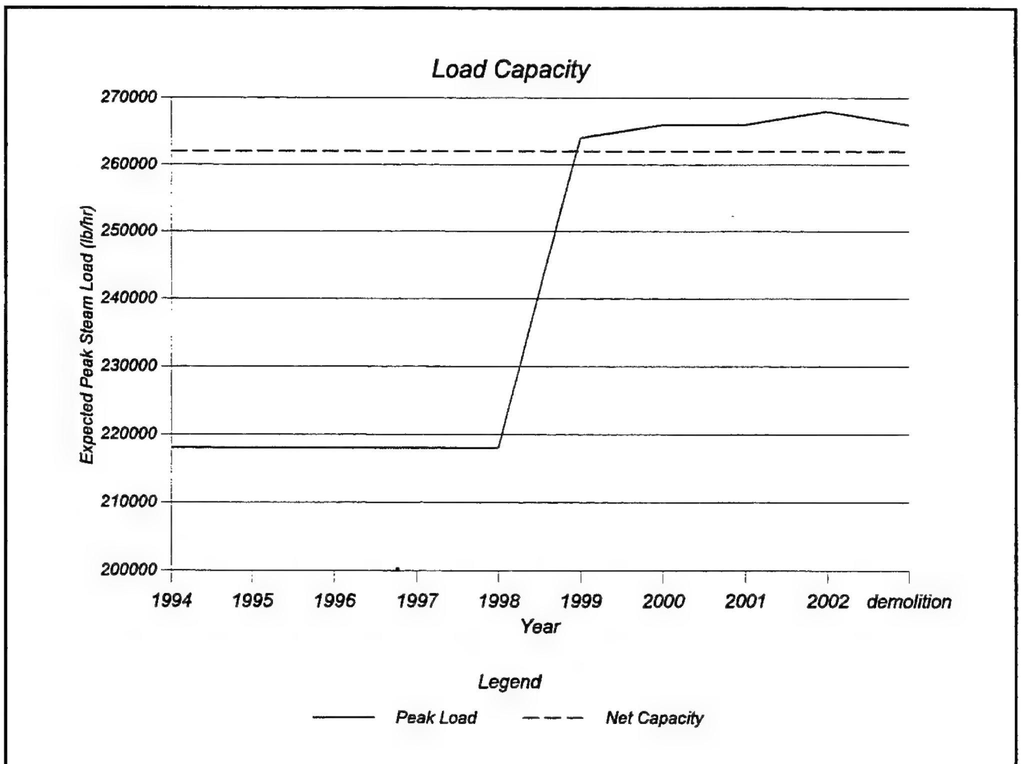
The 1994 winter peak steam load was 218,000 lb/hr. At that time, approximately 1,766,200 square feet was being served steam from the central boiler plant. The winter peak expected with these new loads is 266,000 lb/hr. The existing boiler plant has enough capacity to meet this expected peak of 266,000 lb/hr. If the largest boiler, Boiler No. 3, were to experience mechanical problems on a peak day, the boiler plant would have only 262,000 lb/hr of capacity and could not meet the expected load. The following table shows expected growth by year and its relationship to the plant's net capacity of 262,000 lb/hr.

Expected Peak = 266,000 lb/hr almost

$$218{,}000\ \frac{lb}{hr}\ x \left(\frac{390{,}600\ sf + 1{,}766{,}200\ sf}{1{,}766{,}200\ sf}\right) = 266{,}000\ \frac{lb}{hr}$$

IMPACT OF PROPOSED CONSTRUCTION ON BOILER PLANT

| Year | SF Served | Expected Peak Load | % net Capacity 262,000 lb/yr |
|---|---|---|---|
| 1994 | 1,766,200 | 218,000 | 83.2% |
| 1995 | 1,766,200 | 218,000 | 83.2% |
| 1996 | 1,766,200 | 218,000 | 83.2% |
| 1997 | 1,766,200 | 218,000 | 83.2% |
| 1998 | 1,766,200 | 218,000 | 83.2% |
| 1999 | 2,138,552 | 264,000 | 100.7% |
| 2000 | 2,158,178 | 266,000 | 101.7% |
| 2001 | 2,158,178 | 266,000 | 101.7% |
| 2002 | 2,169,204 | 268,000 | 102.2% |
| Demolition (dates unknown) | 2,156,809 | 266,000 | 101.6% |



Fort Detrick can construct a new boiler plant on the west side of Ditto Road in the vicinity of the proposed future growth. This boiler plant would supplement the existing boiler plant. The new boiler plant would contain two 85,000 lb/hr boilers. Boilers No. 5 and No. 6 would be abandoned or removed. The net steam capacity on the base would increase to 300,000 lb/hr, which is more than enough to cover expected future loads. These new boilers would be operated as much as possible to take advantage of the higher efficiencies.

According to technical data provided by Cleaver Brooks, a new 85,000 lb/hr watertube boiler with an economizer operating at 75% load is expected to be 84% efficient when burning natural gas and 87% efficient when burning No. 6 oil. These efficiencies are observed when the boiler is held at a constant firing rate, not under normal operating conditions. We expect to observe slightly lower efficiencies over the year due to boiler warm-up and load fluctuations. The following efficiency numbers will be used for our analysis.

Gas Efficiency = 80.7%

Oil Efficiency = 83.6%

The two new boilers in combination with Boiler No. 2 have a total capacity of 235,000 lb/hr. The peak observed load in 1994 was 218,000 lb/hr. Boiler No. 2 has efficiency of 80.3% on gas and 83.5% on oil - very similar to expected efficiencies for the new boilers. The combined plant efficiencies are expected to increase.

| | Existing | Proposed |
|---|---|---|
| Plant Gas Efficiency | 76.8% | 80.7% |
| Plant Oil Efficiency | 77.1% | 83.6% |

The expected fuel costs with the new boilers in place and improved plant efficiencies are estimated to be $2,786,900 /yr. This value relates directly to 1994 usage totals.

Natural Gas = 609,654 mcf/yr

$$640{,}613\ mcf\left(\frac{0.768\ eff}{0.807\ eff}\right) = 609{,}654\ \frac{mcf}{yr}$$

No. 6 Fuel Oil = 1,511,437 gal/yr

$$1{,}638{,}860\ \frac{gal}{yr}\ x\left(\frac{0.771\ eff}{0.836\ eff}\right) = 1{,}511{,}437\ \frac{gal}{yr}$$

Fuel Cost = 2,786,900 /yr

$$\left(609{,}654\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}511{,}437\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}786{,}882\ use,\ \$2{,}786{,}900\ /yr$$

**Construction Cost.** The estimated cost to construct the new boiler plant is $4,304,000. The figure includes the structure, two 85,000 lb/hr watertube boilers, and the ancillary equipment.

| | |
|---|---|
| Material | $2,340,000 |
| Labor | 1,520,000 |
| Design Fee | 232,000 |
| SIOH | 212,000 |
| Total | $4,304,000 |

**Savings.** The annual energy cost savings resulting from the implementation of this project is expected to be $162,800.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 640,613 | 609,654 | 30,959 | 4.8% |
| No. 6 Fuel Oil (gal/yr) | 1,633,860 | 1,511,437 | 122,423 | 7.5% |
| Energy Usage (mmBtu/yr) | 904,404 | 854,191 | 50,213 | 5.6% |
| Fuel Cost | $2,949,700 | $2,786,900 | $162,800 | 5.5% |

**Maintenance Savings.** The maintenance and operation cost (-savings) for this ECO is $200,000 per year.

**Discussion.** Payback Period = $\infty$

Savings to Investment Ratio = 0.09

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

We have assumed that these boilers will be connected to the existing distribution system, and that these boilers will initially be heavily utilized because they are the most efficient boilers available. If the boiler plant is placed on the far side of Ditto Road, the losses in the additional transmission lines may offset some of the available savings from efficiency gains.

This project can not move forward on the basis of energy savings alone. The boiler plant must be built because of the need for additional capacity, with energy savings as an added benefit. An additional study of the future needs and their impact on steam availability and production would have to be performed prior to seriously considering such an expansion.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: S-2 NEW BOILER PLANT
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 3860000. | | |
| B. SIOH | $ 212000. | | |
| C. DESIGN COST | $ 232000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 4304000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 4304000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 18325. | $ 51493. | 19.97 | $ 1028320. |
| D. NAT G | $ 3.43 | 31888. | $ 109376. | 20.96 | $ 2292518. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 50213. | $ 160869. | | $ 3320838. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -200000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -2948000.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -2948000.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ -39131.

5. SIMPLE PAYBACK PERIOD (1G/4) ****** YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 372838.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .09
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): -8.77 %

## ECO S-3
## STEAM PRESSURE REDUCTION

**Existing.** Steam currently leaves the boiler plant at 100 psi. The steam is distributed at three different pressures: 100 psi, 50 psi, and 10 psi. The lower pressures, 50 psi, and 10 psi, are achieved by using pressure reducing stations located in steam manholes and inside buildings.

The maximum known steam pressure requirement on the base is for the autoclaves. The larger autoclaves need 60 psi steam to operate properly. At one time, Building 1412 needed 90 psi steam to operate a vacuum ejector. Operators at Building 1412 have informed us that this piece of equipment is no longer in service and their steam pressure requirement has been reduced to 60 psi.

In 1994, approximately \$2,949,700 was spent for fuel used by the boilers to produce 100 psi steam. This figure does not include fuel consumed to bank the boilers.

| | | |
|---|---|---|
| Natural Gas | = | 640,613 mcf/yr |
| No. 6 Fuel Oil | = | 1,638,860 gal/yr |
| Fuel Cost | = | \$2,949,700 /yr |

$$\left(640{,}613\ \frac{mcf}{hr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}638{,}860\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}949{,}685\ \ use,\ \$2{,}949{,}700$$

**Proposed.** Lower the steam pressure leaving the boiler plant to 70 psi. This distribution pressure should allow 60 psi steam to be delivered to any point on the base and account for pressure losses in the distribution system.

Lowering the steam pressure results in a decrease in steam temperature. When the steam is distributed at a lower temperature, the temperature difference between the steam piping and its surroundings will be less. Heat loss from the piping is reduced

resulting in lower losses.

In Section 5.10 of this report, we calculated expected losses in the distribution system due to heat transfer to be 83,468 mlb/yr. Expected losses are reduced to 80,457 mlb/yr when the losses are recalculated using the lower steam pressure and temperature.

Expected Distribution Losses

| | Existing 100 psi, 330°F | Proposed 70 psi, 310°F |
|---|---|---|
| Winter (mlb/yr) | 29,200 | 28,196 |
| Summer (mlb/yr) | 26,444 | 25,442 |
| Spring/Fall (mlb/yr) | 27,824 | 26,819 |
| Total (mlb/yr) | 83,468 | 80,457 |

The steam that is not converted to condensate in the distribution lines (83,468 mlb/yr - 80,457 mlb/yr = 3,011 mlb/yr) is steam that does not need to be produced at the boiler plant. This reduction of steam production results in fuel savings.

In addition, it takes less energy to produce 70 psi steam than 100 psi steam. Less heat must be added in the boiler. Therefore, less fuel is consumed to produce all of the steam generated.

The estimated fuel cost to produce 70 psi steam is $2,910,000.

Natural Gas = 629,443 mcf/yr

No. 6 Fuel Oil = 1,638,860 gal/yr

The amount of energy delivered is the same therefore more 70 PSI STEAM HAS TO BE GENERATED. THUS NO FUEL SAVINGS.

Fuel Cost = \$2,910,000 /yr

$$\left(629{,}443\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}638{,}860\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}910{,}255\ \textit{use},\ \$2{,}910{,}000\ /yr$$

**Construction Cost.** We expect about a 35% reduction in the capacity of the pressure reducing valves at the lower supply pressure of 70 psi. Less steam is forced through the reducing valve at the lower pressure. The existing valves will need to be examined to see if they are sized to work properly at the lower supply pressure.

We have assumed \$112,000 to replace pressure reducing valves.

| | |
|---|---|
| Material | \$60,000 |
| Labor | 40,000 |
| Design Fee | 6,000 |
| SIOH | 6,000 |
| Total | \$112,000 |

**Savings.** The annual energy cost savings resulting from the implementation of this project is expected to be \$39,700.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Natural Gas (mcf/yr) | 640,613 | 629,443 | 11,170 | 1.7% |
| No. 6 Fuel Oil (gal/yr) | 1,638,860 | 1,638,860 | 0 | 0% |
| Energy Usage (mmBtu/yr) | 905,152 | 893,647 | 11,505 | 1.3% |
| Fuel Cost (\$/yr) | \$2,949,700 | \$2,910,000 | \$39,700 | 1.3% |

**Maintenance Savings.** The maintenance and operation savings associated with this ECO is $0.

**Discussion.** Payback Period = 2.8 years

Savings to Investment Ratio = 7.4

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

We recommend that this ECO be implemented in a series of steps. Reduce the pressure by 5 psi first. Operate at 95 psi for a few weeks to see if any problems arise. Then, bring the pressure down another 5 psi. Bringing the pressure down gradually will allow Fort Detrick to evaluate the impact of each 5 psi drop and replace the pressure reducing stations in stages instead of all at once.

If Fort Detrick finds that there are some isolated pieces of equipment that require higher pressure steam, they should consider installing a dedicated steam generator for that load.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: S-3 STEAM PRESSURE REDUCTION
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | | |
|---|---|---|---|---|
| A. CONSTRUCTION COST | $ 100000. | | | |
| B. SIOH | $ 6000. | | | |
| C. DESIGN COST | $ 6000. | | | |
| D. TOTAL COST (1A+1B+1C) | $ 112000. | | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 112000. | |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 11505. | $ 39462. | 20.96 | $ 827127. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 11505. | $ 39462. | | $ 827127. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 39462.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.84 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 827127.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 7.39
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.94 %

## ECO S-4
## IMPROVE CONDENSATE RETURN

**Existing.** The 1994 boiler plant operating logs show that, over the course of the year 37% of the feedwater required by the boilers was composed of condensate returned from the distribution system. The condensate return measured on a daily basis typically fluctuates between 30% and 40%. The condensate return has been recorded as high as 52% and as low as 16%. Pipe leaks and unnecessary process losses are felt to be the primary cause for the poor return totals. ?

Once returned to the plant the condensate is then pumped to the deaerator for use. Steam is injected into the deaerator to heat the condensate return and makeup water mix to the required feedwater temperature. Since returned condensate is about 100°F hotter than raw makeup water, the amount of steam injected can be reduced by improving condensate return.

We estimated the amount of steam injected into the dearator in 1994 in Section 5.9 of this report. Assuming all natural gas cost of steam to heat the deaerator is estimated to be $317,600/yr.

Steam Usage (Deaerator) = 70,967 mlbs/yr

Natural Gas = 89,980 mcf/yr

$$\left( \frac{70{,}967\ mlb\ x\ 1.003\ \frac{mmBtu}{mlb}}{0.768\ x\ 1.03\ \frac{mmBtu}{mcf}} \right) = 89{,}983\ use,\ 89{,}980$$

Fuel Cost = $317,600 /yr

$$\left( 89{,}980\ mcf\ x\ \frac{\$3.53}{mcf} \right) = \$317{,}630\ use,\ \$317{,}600$$

**Proposed.** It is to Fort Detricks benefit to improve condensate return. It takes considerably less energy to raise 165°F condensate to 220°F for use in the boilers than to raise 60°F makeup water to the feedwater temperature.

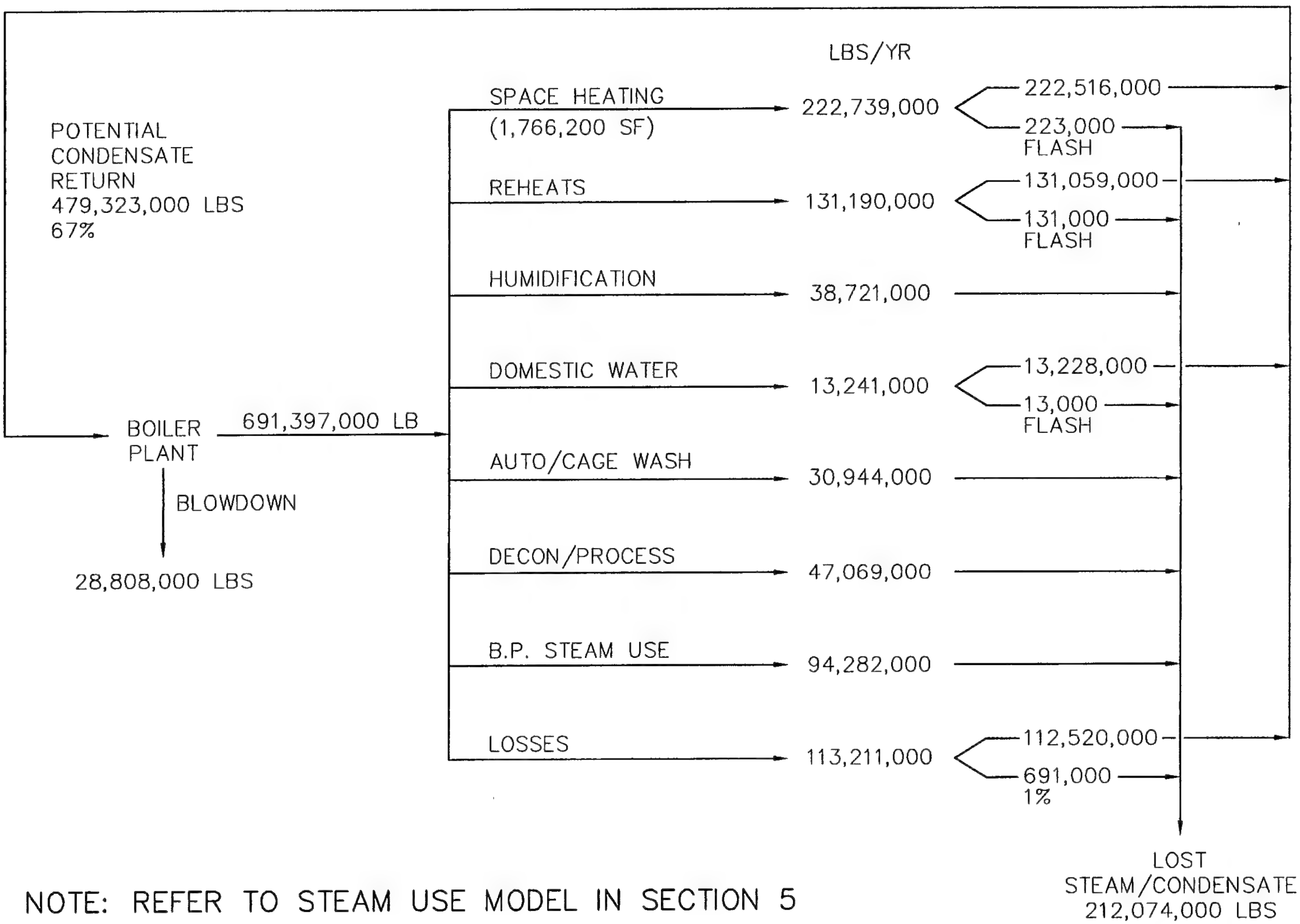
The maximum possible annual condensate return appears to be 67%. Refer to Figure ECO S-4 on the following page We assumed that no steam is returned from humidification, autoclaves, cage washers, sewage decontamination, process loads, or boiler plant steam use. We assumed that 10% of the steam used for space heating, reheats and domestic hot water is lost as flash steam. Finally, we assumed that optimally leaks in the steam and condensate piping could be reduced to 1% of the steam produced.

After reviewing the 1994/1995 helicopter flyover infrared videotapes supplied by Fort Detrick, Entech estimates that there are five areas or sections of pipe that appear to be leaking condensate and/or steam. In all cases the piping is either direct burned or within underground utility tunnels. Entech was only able to view 50-75% of the distribution piping from viewing the two tapes.

Attempting to improve the condensate return to 67% is considered impractical. An assumption of improving the return by 15% (1/2 of 67%-37%) by fixing the major leaks is considered aggressive but achievable and equates to a return total of 52% and a savings of $43,500 /yr. The 15% recovery in physical terms relates to 25 gpm. Review Table ECO S-4 for details on savings associated with improving condensate return. The costs to heat the deaerator based on 52% condensate return is $274,100.

Steam Usage = 61,535 mlbs
(Deaerator)

(70,967 mlbs - 9,723 mlb) = 61,224 mlb




NOTE: REFER TO STEAM USE MODEL IN SECTION 5

| | | | | | | |
|---|---|---|---|---|---|---|
| FORT DETRICK<br>FIGURE S-4 | ENTECH Engineering Inc.<br>4 SOUTH FOURTH STREET P.O. BOX 32 READING, PA 19603 (610) 373-6667<br>1851 WEST END AVE P.O. BOX 389 POTTSVILLE, PA 17901 (717) 628-5655 | | | | | |
| FORT DETRICK STEAM STUDY<br>OPTIMUM CONDENSATE RETURN | DATE<br>7-18-95 | DRAWN BY<br>JTM | CHECKED BY<br>JD | PROJ. MGR.<br>- | APPROVED<br>- | |
| | SCALE<br>NO SCALE | PROJECT NO.<br>4130.03 | | DRAWING NO.<br>FIGS-4 | | REVISION<br>0 |

## Fort Detrick
## Savings Available from Improved Condensate Return
## Table ECO S-4

| Condensate Return | | Makeup Water | | Dearator Steam | | Annual Savings Over Existing | |
|---|---|---|---|---|---|---|---|
| | | | | Steam Inj. | Flash Steam | | |
| (%) | (Lbs.) | (%) | (Lbs.) | (Lbs.) | (Lbs.) | (Lbs.) | (Dollars) |
| 37% | 266,476,000 | 52.6% | 378,756,000 | 71,228,000 | 3,745,000 | 0 | $0 |
| 38% | 273,678,000 | 51.7% | 372,202,000 | 70,580,000 | 3,745,000 | 648,000 | $2,900 |
| 39% | 280,880,000 | 50.8% | 365,648,000 | 69,932,000 | 3,745,000 | 1,296,000 | $5,800 |
| 40% | 288,082,000 | 49.9% | 359,094,000 | 69,284,000 | 3,745,000 | 1,944,000 | $8,700 |
| 41% | 295,284,000 | 49.0% | 352,540,000 | 68,636,000 | 3,745,000 | 2,592,000 | $11,600 |
| 42% | 302,486,000 | 48.0% | 345,986,000 | 67,988,000 | 3,745,000 | 3,240,000 | $14,500 |
| 43% | 309,688,000 | 47.1% | 339,433,000 | 67,339,000 | 3,745,000 | 3,889,000 | $17,400 |
| 44% | 316,890,000 | 46.2% | 332,879,000 | 66,691,000 | 3,745,000 | 4,537,000 | $20,300 |
| 45% | 324,092,000 | 45.3% | 326,325,000 | 66,043,000 | 3,745,000 | 5,185,000 | $23,200 |
| 46% | 331,294,000 | 44.4% | 319,771,000 | 65,395,000 | 3,745,000 | 5,833,000 | $26,100 |
| 47% | 338,496,000 | 43.5% | 313,217,000 | 64,747,000 | 3,745,000 | 6,481,000 | $29,000 |
| 48% | 345,698,000 | 42.6% | 306,663,000 | 64,099,000 | 3,745,000 | 7,129,000 | $31,900 |
| 49% | 352,900,000 | 41.7% | 300,109,000 | 63,451,000 | 3,745,000 | 7,777,000 | $34,800 |
| 50% | 360,103,000 | 40.8% | 293,556,000 | 62,801,000 | 3,745,000 | 8,427,000 | $37,700 |
| 51% | 367,305,000 | 39.9% | 287,002,000 | 62,153,000 | 3,745,000 | 9,075,000 | $40,600 |
| 52% | 374,507,000 | 38.9% | 280,448,000 | 61,505,000 | 3,745,000 | 9,723,000 | $43,500 |
| 53% | 381,709,000 | 38.0% | 273,894,000 | 60,857,000 | 3,745,000 | 10,371,000 | $46,400 |
| 54% | 388,911,000 | 37.1% | 267,340,000 | 60,209,000 | 3,745,000 | 11,019,000 | $49,300 |
| 55% | 396,113,000 | 36.2% | 260,786,000 | 59,561,000 | 3,745,000 | 11,667,000 | $52,200 |
| 56% | 403,315,000 | 35.3% | 254,232,000 | 58,913,000 | 3,745,000 | 12,315,000 | $55,100 |
| 57% | 410,517,000 | 34.4% | 247,678,000 | 58,265,000 | 3,745,000 | 12,963,000 | $58,000 |
| 58% | 417,719,000 | 33.5% | 241,125,000 | 57,616,000 | 3,745,000 | 13,612,000 | $60,900 |
| 59% | 424,921,000 | 32.6% | 234,571,000 | 56,968,000 | 3,745,000 | 14,260,000 | $63,800 |
| 60% | 432,123,000 | 31.7% | 228,017,000 | 56,320,000 | 3,745,000 | 14,908,000 | $66,700 |
| 61% | 439,325,000 | 30.8% | 221,463,000 | 55,672,000 | 3,745,000 | 15,556,000 | $69,600 |
| 62% | 446,527,000 | 29.8% | 214,909,000 | 55,024,000 | 3,745,000 | 16,204,000 | $72,500 |
| 63% | 453,729,000 | 28.9% | 208,355,000 | 54,376,000 | 3,745,000 | 16,852,000 | $75,400 |
| 64% | 460,931,000 | 28.0% | 201,801,000 | 53,728,000 | 3,745,000 | 17,500,000 | $78,300 |
| 65% | 468,133,000 | 27.1% | 195,248,000 | 53,079,000 | 3,745,000 | 18,149,000 | $81,200 |
| 66% | 475,335,000 | 26.2% | 188,694,000 | 52,431,000 | 3,745,000 | 18,797,000 | $84,100 |
| 67% | 482,537,000 | 25.3% | 182,140,000 | 51,783,000 | 3,745,000 | 19,445,000 | $87,000 |

Note: Refer to the dearator mass and heat balance calculation included in Attachment ____ for an explanation of how the makeup water and dearator steam figures were determined.

Natural Gas = 77,654 mcf/yr

$$\left( \frac{61{,}244 \ mlb \ x \ 1.003 \ \frac{mmBtu}{mlb}}{0.768 \ x \ 1.03 \ \frac{mmBtu}{mcf}} \right) = 77{,}654 \ mcf$$

Fuel Cost = $274,100

$$\left( 77{,}654 \ \frac{mcf}{yr} \ x \ \frac{\$3.53}{mcf} \right) = \$274{,}118 \ use, \ \$274{,}100$$

**Construction Cost.** For purposes of this study Entech has assumed that of the five major areas of repair, three are directly buried, and two are installed in the tunnels. In each of the five cases we have assumed that 200 feet of 3" condensate piping, and 200 feet of 8" steam piping will be replaced. The total cost to repair all five areas is estimated to be $321,000.

| | Direct Buried(3) | Tunnel (2) | Total (5) |
|---|---|---|---|
| Material | $63,000 | $32,000 | $95,000 |
| Labor | 114,000 | 78,000 | 192,000 |
| Design Fee | 11,000 | 7,000 | 18,000 |
| SIOH | 10,000 | 6,000 | 16,000 |
| Total | $198,000 | $123,000 | $321,000 |

**Savings.** The annual energy cost savings associated with improving condensate return by 15% is estimated to be $43,500.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Steam Usage (mlbs/yr) | 70,967 | 61,244 | 9,723 | 13.7% |
| Natural Gas (mcf/yr) | 89,890 | 77,654 | 12,326 | 13.7% |
| Energy Usage (mmBtu/yr) | 92,679 | 79,984 | 12,695 | 13.7% |
| Energy Cost | $317,600 | $274,100 | $43,500 | 13.7% |

**Maintenance Savings.** The maintenance savings associated with this ECO is $0. Maintenance of the distribution piping is an on going effort.

**Discussion.** Payback Period = 7.4 years

Savings to Investment Ratio = 2.2

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

In identifying the scope, savings and construction costs for this project, Entech made several assumptions in an effort to develop an appropriate, achievable ECO. The approach required us to determine a scope, which is 5 locations, and expected increase in condensate return which is 15% (37% to 52%). This recovery equates to $43,500 of savings against deaerator heating steam.

The 25 gpm recovery that equates to a 15% increase in condensate return may in fact be accounted for by fixing one or two of the five estimated from a review of the infrared tapes. Additional flyover work covering the remainder of the piping and some field walk downs and testing may lead to determining the key leaks on site.

There are many unknowns about this subject at this time and for that reason it is recommended the system be thoroughly reviewed, however this effort is outside the scope of this project. What is obvious is that a couple of major leaks could be the cause of a large percentage of condensate not returning to the Boiler Plant.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DET-LITE
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: S-4 IMPROVE CONDENSATE RETURN
ANALYSIS DATE: 09-20-95 ECONOMIC LIFE 15 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 287000. | |
| B. SIOH | $ 16000. | |
| C. DESIGN COST | $ 17000. | |
| D. TOTAL COST (1A+1B+1C) | $ 320000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 320000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 12.43 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 13.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 15.09 | $ 0. |
| D. NAT G | $ 3.43 | 12696. | $ 43547. | 15.86 | $ 690660. |
| E. COAL | $ .00 | 0. | $ 0. | 13.61 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 12.64 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 11.85 | $ 0. |
| N. TOTAL | | 12696. | $ 43547. | | $ 690660. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 43547.

5. SIMPLE PAYBACK PERIOD (1G/4) 7.35 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 690660.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.16
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 8.53 %

# ECO S-6
# STEAM AND CONDENSATE METERING

**Existing.** The only buildings known to have steam metering are the USAMRIID buildings - Buildings 1412 and 1425. Fort Detrick's engineering personnel believe those meters to be inaccurate.

In the recent years, condensate return percentages have been an enigma to Fort Detrick personnel. Fluctuations in return numbers from month to month have commonly been ±5%. Some months in past years have shown ± 10% changes from the previous month. Causes for these fluctuations include leakage changes, normal process changes, and abnormal process changes such as suspected steam or condensate dumping.

Average condensate return in 1994 was 37%, and the most optimum return percentage was estimated to be 67% (Refer to ECO S-4). Condensate return totals directly affect the cost to heat the deaerator with steam. This cost is estimated to be $317,600 /yr when all natural gas is assumed.

Steam Usage (Deaerator) = 70,976 mlbs/yr

Natural Gas = 89,980 mcf/yr

$$\left( \frac{70{,}967 \ \frac{mlb}{yr} \ x \ 1.003 \ \frac{mmBtu}{mlb}}{0.768 \ x \ 1.03 \ \frac{mmBtu}{mcf}} \right) = 89{,}980 \ \frac{mcf}{yr}$$

Fuel Cost = $317,600/yr

$$\left( 89{,}980 \ mcf \ x \ \frac{\$3.53}{mcf} \right) = \$317{,}600$$

**Proposed.** Install steam and condensate meters in each building that is provided steam at a rate of 1% or greater of yearly boiler plant feedwater demand. This will allow for the proper monitoring of the primary

users which should aid in determining the condensate changes associated with process variations in these buildings.

Of the 114 buildings serviced by steam, 14 fall into this category. As a group these 14 buildings have been estimated to consume close to 54% of the feedwater. A summary of buildings, load, percentage of feedwater, and connection sizes is shown below. The steam totals in this table are from Table 5.11.1.

**Proposed Building Meters**

| No. | Building | Steam mlbs/yr | * % Site Demand | ** Steam Conn. Size | ** Condensate Conn. Size |
|---|---|---|---|---|---|
| 1 | 375 Steam Sterilization | 47,700 | 6.6% | 8" | 4" |
| 2 | 376 Cancer Research Center (CRC) Lab | 13,600 | 1.9% | 3",3" | 1½" |
| 3 | 469 CRC Lab | 17,900 | 2.5% | 4" | 3" |
| 4 | 538 CRC Lab | 24,100 | 3.4% | 6" | 3" |
| 5 | 539 CRC Lab | 43,500 | 6.0% | 8" | 4" |
| 6 | 550 CRC Lab | 8,100 | 1.1% | 3" | 1½" |
| 7 | 560 CRC Lab | 48,200 | 6.7% | 8" | 4" |
| 8 | 567 CRC Lab | 11,900 | 1.7% | 3" | 1½" |
| 9 | 568 Biomedical R&D Lab | 12,800 | 1.8% | 3" | 1½" |
| 10 | 571 CRC Animal Bldg. | 13,100 | 1.8% | 3" | 1½" |
| 11 | 1022-1049 CRC Animal Bldgs | 17,100 | 2.4% | 4" | 3", 2" |
| 12 | 1301 USDA Labs/offices | 13,300 | 1.8% | 6" | 4", 3" |
| 13 | 1412 USAMRIID Annex Lab | 24,400 | 3.4% | 8" | 2" |
| 14 | 1425 USAMRIID Annex Lab | 76,800 | 10.7% | 16" | 4" |

* This percentage is out of feedwater total which is approximately 720,000 mlbs/yr.

** The line sizes have either been determined during walkdowns, drawing reviews or estimated based on anticipated flows.

For purposes of determining savings for this ECO, a percentage of 5% will be assumed as the potential gain in condensate from monitoring the buildings. These savings are separate from the 15% assumed for ECO S-4.

The 5% total is a typical monthly change and also it is one half of the normal high end changes recorded at the plant. From Table ECO S-4, the increase of 5% savings (37%-42%) is estimated to save 3,240 mlbs/yr of steam production and $14,500 per year in fuel costs.

?

Steam Usage = 67,736 mlbs/yr

$$\left( 70{,}976\ \frac{mlbs}{yr} - 3{,}240\ \frac{mlb}{yr} \right) = 67{,}736\ \frac{mlbs}{yr}$$

Natural Gas = 85,886 mcf/yr

$$\left( \frac{67{,}736\ \frac{mlb}{yr}\ x\ 1.003\ \frac{mmBtu}{mlb}}{0.768\ x\ 1.03\ \frac{mmBtu}{mcf}} \right) = 85{,}886\ \frac{mcf}{yr}$$

Fuel Cost = $303,100/yr

$$\left( 85{,}886\ mcf\ x\ \frac{\$3.53}{mcf} \right) = \$303{,}147\ use,\ \$303{,}100$$

**Construction Cost.** The cost to install steam and condensate meters for the 14 buildings is estimated to be $247,000.

| | |
|---|---|
| Material | $93,000 |
| Labor | 129,000 |
| Design Fee | 13,000 |
| SIOH | 12,000 |
| Total | $247,000 |

**Savings.** The savings associated with improving condensate return from the current 37% level to 42% is estimated to be $14,500. These cost savings are associated with a reduction of the steam consumed by the deaerators in the boiler plant.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Steam Usage (mlbs/yr) | 70,967 | 67,736 | 3,240 | 4.6% |
| Natural Gas (mcf/yr) | 89,980 | 85,886 | 4,094 | 4.6% |
| Energy Usage (mmBtu/yr) | 92,679 | 88,463 | 4,216 | 4.6% |
| Energy Cost | $317,600 | $303,100 | $14,500 | 4.6% |

**Maintenance Savings.** The annual maintenance cost (-savings) expected for this ECO is $15,000.

**Discussion.** Payback Period = $\infty$

Savings to Investment Ratio = 0.33

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

While the monitoring of steam and condensate is not considered an effective energy savings opportunity, it is considered good practice. Along with monitoring the primary users, providing additional meters in and around the boiler plant would aid in the site understanding the steam use, and when there are problems on site. Neither of these strategies though can be recommended based on energy savings alone.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK

ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080

INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3

PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY

FISCAL YEAR 1995 DISCRETE PORTION NAME: S-6 STEAM & CONDENSATE METERING

ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 222000. | | |
| B. SIOH | $ 12000. | | |
| C. DESIGN COST | $ 13000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 247000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 247000. |

2. ENERGY SAVINGS (+) / COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 4217. | $ 14464. | 20.96 | $ 303172. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 4217. | $ 14464. | | $ 303172. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -15000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -221100.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -221100.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ -536.

5. SIMPLE PAYBACK PERIOD (1G/4) ****** YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 82072.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .33
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): -2.43 %

## ECO S-7
## INSULATE STEAM & CONDENSATE LINES

**Existing.** As described in Section 3.3, the insulation condition of the steam piping at the Fort Detrick facility ranges from good for the aboveground piping to poor for the underground tunnel and underground piping. Based on the walkdowns performed by Entech, the condition of the condensate piping and insulation is considered to be the same.

The losses in the steam piping distribution due to heat transfer were estimated in Section 5.10. This table is also included in this ECO and it is labeled as the "existing" estimated pipe losses. From this table, it can be seen that the average estimated losses for the year are 9,500 lb/hr or 12% of the 78,900 lb/hr average steam flow rate for the year. The existing conditions and costs are summarized below.

| | | |
|---|---|---|
| Steam Produced | = | 691,300 mlb/yr |
| Steam Produced (Avg.) | = | 78,900 lb/hr |
| Steam Lost (Avg.)<br>(to heat transfer only) | = | 9,500 lb/hr |
| Natural Gas | = | 640,613 mcf/yr |
| No. 6 Fuel Oil | = | 1,633,860 gal/yr |
| Fuel Cost | = | $2,949,700 /yr |

$$\left(640{,}613\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(1{,}633{,}860\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}949{,}850\ \textit{use},\ \$2{,}949{,}700$$

**Proposed.** The proposed change associated with this ECO is to replace/repair missing, damaged or inadequate insulation on all the underground tunnel steam piping on the site including manhole piping. The final average insulation thickness would be assumed to be 2.5 inches giving an overall U-value of approximately 0.1 Btu/hr-ft$^2$-°F.

The reasons associated with addressing the underground tunnel steam piping only, include:

1. Aboveground piping appears to be well insulated.

2. The heat loss from the steam piping is about 10 times higher than condensate piping.

3. Underground tunnel piping constitutes the majority of site piping and for the most part it is accessible, although the tunnels are considered access controlled space 5.

4. Manholes which are part of the underground tunnel system appear to be loosing the majority of the heat based on the results of the flyover infrared videotapes.

5. Underground piping is not accessible unless it is excavated. The ground itself is a decent insulator, and the site linear footage totals for this piping are minimal.

If the overall U-value for the underground tunnel piping can be reduced to 0.1, the total losses for all the piping would be reduced to approximately 5,000 lb/hr. This is a result of averaging the summer and winter losses shown in the "proposed" losses spreadsheet, Table ECO S-7. This value then becomes 6% of the site demand and which was reduced to 74,400 lb/hr. The proposed production changes and costs are shown below. Natural gas savings only were assumed with this ECO.

Steam Produced (Avg.) = 74,400 lb/hr

$$(78{,}900 - (9{,}500 - 5{,}000)) = 74{,}400\frac{lb}{hr}$$

Steam Produced = 651,700 mlb/yr

$$\left(74{,}400\ \frac{lb}{yr}\ x\ 8{,}760\ \frac{hr}{yr}\right) = 651{,}744\ \ use,\ 651{,}700\ \frac{mlb}{yr}$$

Natural Gas = 588,900 mcf/yr

$$\left(\left(\frac{671{,}700\ \frac{mlb}{yr}}{.768}\ x\ \frac{1.003\ \ mmBtu}{mlb}\right) - \left(1{,}633{,}860\ \ gal\ \ x\ \ 0.14969\ \frac{mmBtu}{gal}\right)\right)\ x\ \frac{1\ \ mcf}{1.03\ \ mmBtu} = 588{,}875\ \ use,\ 588{,}900\ \frac{mcf}{yr}$$

No. 6 Fuel Oil = 1,633,860

Fuel Cost = $2,765,000

$$\left(588{,}900\ \frac{mcf}{yr}\ x\ \$3.53\right) + \left(1{,}633{,}860\ \frac{gal}{yr}\ x\ \frac{\$0.42}{gal}\right) = \$2{,}765{,}038\ \ use,\ \$2{,}765{,}000$$

**Construction Cost.** The construction cost associated with the upgrade of the insulation on the under tunnel steam piping is $1,008,000.

| | |
|---|---|
| Material | $ 326,000 |
| Labor | 578,000 |
| Design Fee | 54,000 |
| SIOH | 50,000 |
| Total | $1,008,000 |

## Ft. Detrick
## Details for Estimated Steam Pipe Losses

### Table ECO S-7

### Existing

| Period | % Pipe | Est. Total Ft. | Ave. U | Ave. O.D. | Ave. Thick | Total Area | Pipe Temp. | Amb.Temp | Btu's Lost | lb/hr |
|---|---|---|---|---|---|---|---|---|---|---|
| Underground (Summer) | 10% | 4,300 | 0.2 | 8.75 | 0 | 9,850 | 330 | 55 | 595,939 | 662 |
| Under Tunnel (Summer) | 55% | 23,650 | 0.3 | 8.75 | 1.5 | 72,751 | 330 | 65 | 6,362,070 | 7,069 |
| Aboveground (Summer) | 35% | 15,050 | 0.08 | 8.75 | 2.5 | 54,176 | 330 | 80 | 1,191,877 | 1,324 |
| Totals | | 43,000 | | | | 136,777 | | | 8,149,886 | 9,055 |

| Period | % Pipe | Est. Total Ft. | Ave. U | Ave. O.D. | Ave. Thick | Total Area | Pipe Temp. | Amb.Temp | Btu's Lost | lb/hr |
|---|---|---|---|---|---|---|---|---|---|---|
| Underground (Winter) | 10% | 4,300 | 0.2 | 8.75 | 0 | 9,850 | 330 | 50 | 606,774 | 674 |
| Under Tunnel (Winter) | 55% | 23,650 | 0.3 | 8.75 | 1.5 | 72,751 | 330 | 40 | 6,962,266 | 7,736 |
| Aboveground (Winter) | 35% | 15,050 | 0.08 | 8.75 | 2.5 | 54,176 | 330 | 30 | 1,430,253 | 1,589 |
| Totals | | 43,000 | | | | 136,777 | | | 8,999,292 | 9,999 |

## Ft. Detrick
## Details for Estimated Steam Pipe Losses
### Proposed

| Period | % Pipe | Est. Total Ft. | Ave. U | Ave. O.D. | Ave. Thick | Total Area | Pipe Temp. | Amb.Temp | Btu's Lost | lb/hr |
|---|---|---|---|---|---|---|---|---|---|---|
| Underground (Summer) | 10% | 4,300 | 0.2 | 8.75 | 0 | 9,850 | 330 | 55 | 595,939 | 662 |
| Under Tunnel (Summer) | 55% | 23,650 | 0.1 | 8.75 | 2.5 | 85,134 | 330 | 65 | 2,481,659 | 2,757 |
| Aboveground (Summer) | 35% | 15,050 | 0.08 | 8.75 | 2.5 | 54,176 | 330 | 80 | 1,191,877 | 1,324 |
| Totals | | 43,000 | | | | 149,161 | | | 4,269,474 | 4,744 |

| Period | % Pipe | Est. Total Ft. | Ave. U | Ave. O.D. | Ave. Thick | Total Area | Pipe Temp. | Amb.Temp | Btu's Lost | lb/hr |
|---|---|---|---|---|---|---|---|---|---|---|
| Underground (Winter) | 10% | 4,300 | 0.2 | 8.75 | 0 | 9,850 | 330 | 50 | 606,774 | 674 |
| Under Tunnel (Winter) | 55% | 23,650 | 0.1 | 8.75 | 2.5 | 85,134 | 330 | 40 | 2,715,777 | 3,018 |
| Aboveground (Winter) | 35% | 15,050 | 0.08 | 8.75 | 2.5 | 54,176 | 330 | 30 | 1,430,253 | 1,589 |
| Totals | | 43,000 | | | | 149,161 | | | 4,752,804 | 5,281 |

**Savings.** The savings associated with the insulation upgrade on the under tunnel steam piping would be $184,700.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Steam Produced Avg.(lb/hr) | 78,900 | 74,400 | 4,500 | 5.7% |
| Steam Produced (mlb/yr) | 691,300 | 651,700 | 39,600 | 5.7% |
| Natural Gas (mcf/yr) | 640,613 | 588,900 | 51,713 | 8.1% |
| No. 6 Fuel Oil (gal/yr) | 1,633,860 | 1,633,860 | 0 | 0% |
| Energy Usage (mmBtu/yr) | 904,400 | 851,140 | 53,260 | 5.9% |
| Steam Energy Cost ($/yr) | $2,949,700 | $2,765,100 | $184,700 | 6.3% |

**Maintenance Savings.** The annual maintenance savings associated with this ECO is $0.

**Discussion.** Payback Period = 5.5 years

Savings to Investment Ratio = 2.9

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

The payback and life cycle values are associated with upgrading the insulation on the underground tunnel steam piping . The majority of the piping is assumed to be difficult to access but achievable.

In addition to the steam piping, Entech also reviewed the savings and costs associated with providing insulation on the condensate lines in the same tunnels. It was assumed that these lines are in a condition similar to the steam piping. Presently the condensate is returned at a temperature of 165°F and at the rate of 37% on the feedwater used in the boilers. It was estimated that improving the insulation to a degree that would increase the temperature by 15°F to 180°F, would save about $16,000 /yr.

An estimated pipe size of 3" with 1½" insulation would then equate to a construction cost of $249,000 assuming the same amount of piping involved. The cost associated with the accessing and restoration of tunnel entrances and piping was not included because the work could be done at the same time as the steam piping. In addition, good engineering and maintenance practice would suggest that both be insulated at the same time. The payback associated with the condensate piping alone, assuming the tunnels are accessible, is approximately 15.6 years ($240,000 ÷ $16,000).

Based on the findings of this ECO, Entech recommends that this upgrade of the distribution system should be considered further. A detailed field survey should be undertaken including a full inspection of all piping insulation. To develop the project scope and confirm that the assumptions used in this ECO are reasonable. Other advantages of such an effort would include the hands-on inspection of piping for leaks, etc. while the tunnels are accessed, preventing further deterioration.

The combined construction costs for insulating both steam and condensate is $1,257,000. The payback for doing both is 7.0 years The SIR for the two combined is 2.3.

LIFE CYCLE COST ANALYSIS SUMMARY                STUDY: DET-LITE
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)         LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK   REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03   FT. DETRICK STEAM STUDY
FISCAL YEAR 1995   DISCRETE PORTION NAME: S-7 INSULATE STEAM ONLY
ANALYSIS DATE: 09-20-95   ECONOMIC LIFE 15 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 904000. | |
| B. SIOH | $ 50000. | |
| C. DESIGN COST | $ 54000. | |
| D. TOTAL COST (1A+1B+1C) | $ 1008000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 1008000. |

2. ENERGY SAVINGS (+) / COST (-)

DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 12.43 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 13.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 15.09 | $ 0. |
| D. NAT G | $ 3.43 | 53264. | $ 182696. | 15.86 | $ 2897551. |
| E. COAL | $ .00 | 0. | $ 0. | 13.61 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 12.64 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 11.85 | $ 0. |
| N. TOTAL | | 53264. | $ 182696. | | $ 2897551. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 0. |
| (1) DISCOUNT FACTOR (TABLE A) | 11.85 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 0. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 182696.

5. SIMPLE PAYBACK PERIOD (1G/4)   5.52 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)   $ 2897551.

7. SAVINGS TO INVESTMENT RATIO   (SIR)=(6 / 1G)=   2.87
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):   10.62 %

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DET-LITE
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: S-7 INSULATE STEAM & CONDENSATE
ANALYSIS DATE: 09-20-95 ECONOMIC LIFE 15 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 1257000. | | |
| B. SIOH | $ 69000. | | |
| C. DESIGN COST | $ 75000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 1401000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 1401000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 12.43 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 13.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 15.09 | $ 0. |
| D. NAT G | $ 3.43 | 57929. | $ 198696. | 15.86 | $ 3151326. |
| E. COAL | $ .00 | 0. | $ 0. | 13.61 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 12.64 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 11.85 | $ 0. |
| N. TOTAL | | 57929. | $ 198696. | | $ 3151326. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 198696.

5. SIMPLE PAYBACK PERIOD (1G/4) 7.05 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 3151326.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.25
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 8.83 %

## ECO S-8
## REPLACE STEAM HUMIDIFICATION WITH ULTRASONIC

**Existing.** Humidification is required in the buildings at Fort Detrick that use a large amount of outdoor air during the winter. As described in Section 5.4, these buildings include animal buildings, buildings with animal labs, Buildings 1412 and 1425 (USAMRIID), and Building 915 (the Bowling Center). Fort Detrick currently provides humidification by injecting steam directly into the air entering the building.

Entech was not permitted to enter the buildings at Fort Detrick because of the type of work that is done there. We were unable to locate detailed information about humidification requirements for each building through interviews with Fort Detrick personnel. For this reason, we based this evaluation on a single assumed typical 20,000 cfm system to provide 72°F and 50% indoor relative humidity. We assumed that the building where this system is installed requires 100% outdoor air. This is the case in the animal buildings and animal labs.

The estimated cost to produce steam for humidification for 20,000 cfm system is $5,400 /year. This is based on the use of natural gas for this system. Refer to Attachment 8.5 for calculation details.

Steam Produced = 1,207 mlbs/yr

Natural Gas = 1,530 mcf/yr

$$\left(\frac{1{,}207\ \frac{mlb}{yr} \cdot x\ \frac{1.003\ \ mmBtu}{mlb}}{0.768\ \ (eff)}\right)\ x\ \frac{1\ \ mcf}{1.03\ \ mmBtu} = 1{,}530\ \frac{mcf}{yr}$$

Fuel Cost = $5,400

$$\left(1{,}530\ \frac{mcf}{yr}\ x\ \$3.53\right) = \$5{,}401\ \ use,\ \ \$5{,}400$$

**Proposed.** Replace existing steam humidifiers with ultrasonic humidifiers. Ultrasonic humidifiers use compressed air to atomize water for injection into air entering the occupied spaces. When 100% outdoor air is required, as we have here, the outdoor air must be heated prior to humidification so the air can hold the moisture required for 50% relative humidity. Steam would be used to preheat the air.

Put Humidifier down stream of heating coil

The estimated annual cost to preheat the air and operate the compressor used for atomization is $6,500 per year.

Steam Produced = 1,123 mlb/yr

Natural Gas = 1,425 mcf/yr

$$\left(1{,}123\ \frac{mlb}{yr}\ x\ \frac{1.003\ \frac{mmBtu}{mlb}}{0.768\ (eff)}\right)\ x\ \frac{1\ mcf}{1.03\ mmBtu} = 1{,}424\ use,\ 1{,}425\ \frac{mcf}{yr}$$

Electric Demand = 93 kW/yr

Electric Usage = 26,856 kWh/yr

Energy Cost = $6,500

$$\left(1{,}425\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) + \left(93\ \frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(26{,}856\ \frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$6{,}509\ use,\ \$6{,}500$$

**Construction Cost.** The estimated cost to install the equipment required for implementation of this ECO is $87,000. This figure includes the humidification unit and controls, a compressor, a preheat coil, and the piping, controls and accessories required.

| | |
|---|---|
| Material | $54,000 |
| Labor | 24,000 |
| Design Fee | 5,000 |
| SIOH | 4,000 |
| Total | $87,000 |

**Savings.** There are no annual energy cost savings expected from implementation of this project.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Steam Produced (mlbs/yr) | 1,207 | 1,123 | 84 | 7% |
| Natural Gas (mcf/yr) | 1,530 | 1,425 | 105 | 7% |
| Electric Demand (kW/yr) | 0 | 93 | -93 | -100% |
| Electric Usage (kWh/yr) | 0 | 26,856 | -26,856 | -100% |
| Energy Usage (mmBtu/yr) | 1,576 | 1,559 | 17 | 1% |
| Energy Cost | $5,400 | $6,500 | -$1,100 | -20% |

**Maintenance Savings.** The maintenance cost (-savings) associated with this ECO is $2,000.

**Discussion.** Payback Period = ∞

Savings to Investment Ratio = -0.17

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

The energy required to preheat the outdoor air before adding humidification is almost equal to the energy required for direct steam injection. This type of system is only economically feasible in a facility with average to low outdoor air requirements. The warm air returned from the occupied space can then be mixed with outdoor air to attain the air temperature needed for humidification. The applicability of ultrasonic humidification would need to be evaluated on a case by case basis.

One has condensate the other doesn't, big difference

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080

INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: S-8 REPLACE STM. HUMID. W/ULTRAS
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 78000. | | |
| B. SIOH | $ 4000. | | |
| C. DESIGN COST | $ 5000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 87000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 87000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | -92. | $ -647. | 15.61 | $ -10096. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 108. | $ 370. | 20.96 | $ 7764. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ -834. | 14.74 | $ -12293. |
| N. TOTAL | | 16. | $ -1110. | | $ -14625. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 0.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 0.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ -1110.

5. SIMPLE PAYBACK PERIOD (1G/4) -78.36 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ -14625.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= -.17
(IF < 1 PROJECT DOES NOT QUALIFY)

**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

## ECO S-9
## SEWAGE STORAGE TANK INSULATION

**Existing.** The contaminated sewage treatment plant, Building 375, utilizes nine horizontal cyundrical tanks (12 feet diameter x 60 feet long) as part of the system. The contaminated sewage treatment process is a continuous system that depends on these tanks for surge and storage. Steam is injected directly into the tank to maintain a minimum fluid temperature of 65°F. The tanks are presently installed without insulation. The heat loss associated with operating one of these tanks in the winter months is estimated to be 62,750 Btu/hr. While the same tank in the intermediate spring/fall months has an estimated loss rate of 19,500 Btu/hr. The tank heat loss during the summer is assumed to be zero. The calculations associated with determining these heat loss values is included with this ECO. The cost to heat all nine, if assumed to operate at the same fluid levels during the year is $8,470.

Steam Usage (nine tanks) = 1,890 mlb/yr

$$9\ x\left(\left(62{,}750\ \frac{Btu}{hr} + 19{,}500\ \frac{Btu}{hr}\right) \div \left(1{,}187\ \frac{Btu}{lb} - 33\ \frac{Btu}{lb}\right)\right)\ x\left(8{,}760\ \frac{hrs}{yr}\ x\ \frac{.33\ yr}{yr}\ x\ \frac{1\ mlb}{1{,}000\ lb}\right) = 1{,}873\ use,\ 1890\ \frac{mlb}{yr}$$

Natural Gas = 2,400 mcf/yr

$$\left(\frac{1{,}890\ \frac{mlb}{yr}\ x\ 1.003\ \frac{mmBtu}{mlb}}{0.768}\right)\ x\ \frac{1\ mcf}{1.03\ mmBtu} = 2{,}396\ use,\ 2{,}400\ \frac{mcf}{yr}$$

Steam Cost (nine tanks) = $8,470 /yr

$$\left(2{,}400\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf}\right) = \$8{,}472\ use,\ \$8{,}470\ /yr$$

**Proposed.** Install R-10 insulation on all nine tanks. The estimated winter and summer/fall expected heat loss from one of these insulated tanks is estimated to be 8,500 Btu/hr, 3,000 Btu/hr, respectively. The total cost to heat the nine tanks would be $1,170.

Steam Usage = 260 mlb/yr
(nine tanks)

$$9 \ x \left( \left( 8{,}500 \ \frac{Btu}{hr} + 3{,}000 \ \frac{Btu}{hr} \right) \div \left( 1{,}187 \ \frac{Btu}{lb} - 33 \ \frac{Btu}{lb} \right) \right) x \left( 8{,}760 \ \frac{hrs}{yr} \ x \ \frac{.33 \ yr}{yr} \ x \ \frac{1 \ mlb}{1{,}000 \ lb} \right) = 260 \ \frac{mlb}{yr}$$

Natural Gas = 330 mcf/yr

$$\left( \frac{260 \ \frac{mlb}{yr} \ x \ 1.003 \ \frac{mmBtu}{mlb}}{0.768} \right) x \ \frac{1 \ mcf}{1.03 \ mmBtu} = 330 \ \frac{mcf}{yr}$$

Fuel Cost = $1,170 /yr
(nine tanks)

$$\left( 330 \ \frac{mcf}{yr} \ x \ \frac{\$3.53}{mcf} \right) = \$1{,}165 \ use, \ \$1{,}170 \ /yr$$

**Construction Cost.** The anticipated construction cost to insulate the nine tanks is $298,000.

| | |
|---|---|
| Material | $ 95,000 |
| Labor | 172,000 |
| Design Fee | 16,000 |
| SIOH | 15,000 |
| Total | $298,000 |

**Savings.** The cost savings associated with energy (steam) use is $7,300.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Steam Usage (mlbs/yr) | 1,890 | 260 | 1,630 | 86% |
| Natural Gas (mcf/yr) | 2,400 | 330 | 2,070 | 86% |
| Energy Usage (mmBtu/yr) | 2,472 | 340 | 2,132 | 86% |
| Steam Cost | $8,470 | $1,170 | $7,300 | 86% |

**Maintenance Savings.** The expected maintenance cost (-savings) for this ECO is $1,000.

**Discussion.** Payback Period = 47 years

Savings to Investment Ratio = 0.46

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

LIFE CYCLE COST ANALYSIS SUMMARY  STUDY: DETRICK
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)  LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK  REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03  FT. DETRICK STEAM STUDY
FISCAL YEAR 1995  DISCRETE PORTION NAME: S-9 SEWAGE STORAGE TANK INSULATO
ANALYSIS DATE: 07-19-95  ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 267000. | |
| B. SIOH | $ 15000. | |
| C. DESIGN COST | $ 16000. | |
| D. TOTAL COST (1A+1B+1C) | $ 298000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 298000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 2132. | $ 7313. | 20.96 | $ 153275. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 2132. | $ 7313. | | $ 153275. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-)  $ -1000.
(1) DISCOUNT FACTOR (TABLE A)  14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1)  $ -14740.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -14740.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 6313.

5. SIMPLE PAYBACK PERIOD (1G/4)  47.21 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C)  $ 138535.

7. SAVINGS TO INVESTMENT RATIO  (SIR)=(6 / 1G)=  .46
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR):  -.77 %

# ECO S-10
# REDUCE CONTAMINATED SEWAGE

**Existing.** Fort Detrick uses a decontamination process that includes direct steam injection into its contaminated sewage. The site has both contaminated and non-contaminated or "normal" sewage systems on the site. The normal sewage system sources are from most of the buildings and areas in the facility, while the contaminated system sources are concentrated around the research and laboratory buildings on both the U.S. Army portion of the site and the National Cancer Institute facility. The buildings serviced by the contaminated system include 326, 374-376, 427-434, 538-539, 549-550, 560, 567-568, 660, 1412, and 1425. It should be noted that large areas behind many of these buildings only have contaminated sewage lines, possibly leading to unnecessary connections to those lines. Refer to copies of the utility drawings in Attachment 8.5.

Table 5.7.1 summarized the metered gallons of contaminated sewage, and the associated estimated steam totals for a one year period. The trend shown in this table is that the metered sewage more than doubles in August from its low in February. The total steam cost associated with processing this sewage is $203,300 /yr.

Metered Sewage = 88,352,500 gal/yr

Steam Usage = 45,400 mlb/yr

$$\left(88{,}352{,}500\ \frac{gal}{yr}\ x\ \frac{8.3\ lbs}{gal}\ x\ \frac{1\ mlb}{1{,}000\ lb}\ x\ .0619\ \frac{lb\ steam}{lb\ sewage}\right) = 45{,}352\ use,\ 45{,}400\ \frac{mlb}{yr}$$

Natural Gas = 57,600 mcf/yr

$$\left(\frac{45{,}400\ \frac{mlb}{yr}\ x\ \frac{1.003\ mmBtu}{mlb}}{0.768\ (eff)}\right) x\ \frac{1\ mcf}{1.03\ mmBtu} = 57{,}565\ use,\ 57{,}600\ \frac{mcf}{yr}$$

Fuel Cost = \$203,300 year

$$\left(57{,}600\ \frac{mcf}{yr}\ x\ \$3.53\right) = \$203{,}328\ \ use,\ \$203{,}300$$

**Proposed.** From the trends discussed earlier, there is a significant increase in the contaminated sewage during the warmer months peaking in July and August. This trend suggests that warm weather operations such as cooling tower blowdown, increased washdown of lab areas, etc. may be the reasons. Assuming that the average monthly sewage should normally be around 6,000,000 gallons, the total for the year would then equate to 72,000,000. This in turn would relate to a heating cost of \$163,000 /yr. The reduction to these totals assumes that the practices noted above could be stopped, or changed to normal sewage by adding piping, lift stations, etc.

Metered Sewage = 72,000,000 gal/yr

Steam Usage = 37,000 mlb/yr

$$\left(72{,}000{,}000\ \frac{gal}{yr}\ x\ 8.3\ \frac{lbs}{gal}\ x\ \frac{1\ mlb}{1{,}000\ lb}\ x\ 0.0619\ \frac{lb\ steam}{lb\ sewage}\right) = 36{,}991\ \ use,\ 37{,}000\ \frac{mlb}{yr}$$

Natural Gas = 46,900 mcf/yr

$$\left(\frac{37{,}000\ \frac{mlb}{yr}\ x\ \frac{1.003\ mmBtu}{mlb}}{0.768\ (eff)}\right)\ x\ \frac{1\ mcf}{1.03\ mmBtu} = 46{,}914\ \ use,\ 46{,}900\ \frac{mcf}{yr}$$

Fuel Cost = \$165,600 year

$$\left(46{,}900\ \frac{mcf}{yr}\ x\ \$3.53\right) = \$165{,}557\ \ use,\ \$165{,}600$$

**Construction Cost.** Estimating the costs associated with realizing these changes are difficult to predict. Refer to the discussion section for related information on construction costs. The cost associated with the 9.9 year payback period is \$373,000.

| | |
|---|---|
| Material | $134,000 |
| Labor | 201,000 |
| Design Fee | 20,000 |
| SIOH | 18,000 |
| Total | $373,000 |

**Savings.** The costs savings associated with reducing the total contaminated sewage by more than 16,000,000 gallons would be $37,700.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Metered Sewage (gal/yr) | 88,352,500 | 72,000,000 | 16,352,500 | 18.5% |
| Steam Usage (mlb/yr) | 45,400 | 37,000 | 8,400 | 18.5% |
| Natural Gas (mcf/yr) | 57,600 | 46,900 | 10,700 | 18.6% |
| Energy Usage (mmBtu/yr) | 59,330 | 48,300 | 11,030 | 18.6% |
| Energy Cost | $203,300 | $165,600 | $37,700 | 18.5% |

**Maintenance Savings.** The maintenance costs for associated with adding piping, pumps, etc. is estimated to be $5,000/yr.

**Discussion.** Payback Period = 9.9 years

Savings to Investment Ratio = 2.1

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

The trends in metered sewage points towards seasonal practices and impacts. Cooling tower blowdown is potentially a large contributor to this phenomena. If all the savings speculated in this ECO could be achieved, then the available constructions costs associated with an 9.9 year payback would be $373,000 ($37,700/yr x 9.9 yrs). A field survey would be required to identify the potential changes and the associated construction costs.

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: S-10 REDUCE CONTAMINATED SEWAGE
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 335000. | | |
| B. SIOH | $ 18000. | | |
| C. DESIGN COST | $ 20000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 373000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 373000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 0. | $ 0. | 15.61 | $ 0. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 11021. | $ 37802. | 20.96 | $ 792331. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 0. | 14.74 | $ 0. |
| N. TOTAL | | 11021. | $ 37802. | | $ 792331. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 0. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.74 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 0. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 37802.

5. SIMPLE PAYBACK PERIOD (1G/4) 9.87 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 792331.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 2.12
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 7.06 %

## 6.6 (P) Plant

The following section contains the evaluations for the ECOs investigating the opportunities associated with electrical (excluding lighting) and/or steam energy consumption within the Boiler Plant. They are ECO P1 through P-3

P-1 Turbine Drives on Feedwater Pumps
P-2 Efficient Motors
P-3 Variable Speed Drives

## ECO P-1
## TURBINE DRIVES ON FEEDWATER PUMPS

**Existing.** Presently Fort Detrick utilizes electric motors for driving feedwater pumps in the boiler plant. In particular, Feedwater Pumps 2 and 4 were identified as the pumps that carry the load through the year. Pump 4 (275 gpm @ 420 ft TDH, 50 HP @ 3500 rpm) in the winter season and pump 2 (275 gpm @ 355 ft TDH, 40 HP @ 3500 rpm) during the remainder of the year. The demand and usage totals for running feedwater pumps in 1994 were estimated to be 470 kW and 238,100 kWh respectively. The feedwater pumping electric energy costs for the year were estimated to be $9,930. Refer to Table 5.14.1 for details pertaining to the electric costs in the boiler plant.

Electric Demand = 470 kW/yr

Electric Usage = 238,123 kWh/yr

Electric Cost = $9,930 year

The total amount of steam generated for the year was 691,400 mlbs or a yearly average of 78,900 lbs/hr. From Table 5.9.1 the amount of steam required to heat the feedwater is 75,500 mlbs. The yearly average was 8,620 lbs/hr for dearator heating. The estimated cost of generating steam for the dearator is $308,250.

Steam Usage (dearator) = 75,500 mlbs/yr

Natural Gas = 95,700 mcf/yr

$$\left( \frac{75{,}000\ \frac{mlbs}{yr}\ x\ \frac{1.003\ \ mmBtu}{mlb}}{0.768} \right)\ x\ \frac{1\ \ mcf}{1.03\ \ mmBtu} = 95{,}730\ \ use,\ 95{,}700\ \frac{mcf}{yr}$$

Fuel Cost = $338,000

$$\left( 95{,}700\ \frac{mcf}{yr}\ x\ \frac{\$3.53}{mcf} \right) = \$337{,}821\ \ use,\ \$338{,}000$$

**Proposed.** The proposed change is to replace the electric motor on either feedwater pump 4 or 5 with a steam turbine drive, and utilize it throughout the year to handle the base load pumping.

The yearly steam flow average for the plant is 78,900 lbs/hr which equates to approximately 170 gpm of feedwater. Any of the five pumps can easily handle this flow. Therefore one pump would be used requiring a steam demand up to 3,000 lb/hr according to the vendors selection attached for a 50 HP motor drive. For determining the energy required for operating this drive we will assume that the average flow with diversity for the year will be 2,500 lb/hr. The steam from the outlet of the turbine would continue on to the deaerators minus the energy to run the pump. The additional steam energy and costs required to run this pump were calculated to be \$4,200. The total costs to heat feedwater in the deaerators becomes \$342,000. The total electric costs are reduced to \$2,300.

Steam Usage = 21,900 mlbs/yr
(Steam thru pump)

$$\left(2.5\ \frac{mlbs}{hr}\ x\ 8{,}760\ \frac{hr}{yr}\right) = 21{,}900\ \frac{mlb}{yr}$$

Steam Energy = 970 mmBtu
(to pump shaft)

$$\left(2.5\frac{mlb}{hr}\ x\ 8{,}760\frac{hr}{yr}\ x\ 0.134\frac{mmBtu}{mlb}\ (110\ psig \Rightarrow 5\ psig)\ x\ 0.33(eff.)\right) = 968\ use,\ 970\ mmBtu$$

Steam Usage = 76,470 mlb/yr
(Deaerator)

$$\left(75{,}500\ \frac{mlb}{yr} + \left(970\ mmBtu\ x\ \frac{1\ mlb}{1.006\ mmBtu}\right)\right) = 76{,}467\ use,\ 76{,}470\ \frac{mlb}{yr}$$

Natural Gas = 97,000 mcf/yr

$$\left(\frac{76{,}470\ \frac{mlb}{yr}\ x\ \frac{1.003\ mmBtu}{mlb}}{0.768\ (eff)}\right)\ x\ \frac{1\ mcf}{1.03\ mmBtu} = 96{,}965\ use,\ 97{,}000\ \frac{mcf}{yr}$$

Fuel Cost = $342,000 year

$$\left(97{,}000\ \frac{mcf}{yr}\ x\ \$3.53\right) = \$342{,}410\ use,\ \$342{,}000$$

Electric Demand = 180 kW/yr

$$\left(470\ \frac{kW}{yr} - \left(4\ \frac{mo}{yr}\ x\ 28\ \frac{kW}{mo}\right) - \left(8\ \frac{mo}{yr}\ x\ 22.4\ \frac{kW}{mo}\right)\right) = 178\ use,\ 180\ \frac{kW}{yr}$$

Electric Usage = 28,600 kWh/yr

$$\left(238{,}100\frac{kWh}{yr} - \left(4\frac{mo}{yr}\ x\ 20{,}142\frac{kWh}{mo}\right) - \left(8\frac{mo}{yr}\ x\ 16{,}114\frac{kWh}{mo}\right)\right) = 28{,}620\ use,\ 28{,}600\ \frac{kWh}{yr}$$

Electric Cost = $2,300 /yr

$$\left(180\ \frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(28{,}600\ \frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$2{,}301\ use,\ \$2{,}300$$

**Construction Cost.** The expected construction cost for the project will be $60,000. Reference cost estimate attached.

| | |
|---|---|
| Material | $27,000 |
| Labor | 27,000 |
| Design Fee | 3,000 |
| SIOH | 3,000 |
| Total | $60,000 |

**Savings.** The annual cost savings resulting from the implementation of this project will be $4,000.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Dearator Steam (mlb/yr) | 75,500 | 76,470 | -970 | -1.3% |
| Natural Gas (mcf/yr) | 95,700 | 97,000 | -1,300 | -1.4% |
| Electric Demand (kW/yr) | 470 | 180 | 290 | 61.7% |
| Electric Usage (kW/yr) | 238,100 | 28,600 | 209,500 | 88.0% |
| Energy Usage (mmBtu/yr) | 99,384 | 100,008 | -624 | -0.6% |
| Total Cost | $348,000 | $344,000 | $4,000 | 1.1% |

**Maintenance Savings.** The annual maintenance costs (-savings) estimated for this ECO is $1,000.

**Discussion.** Payback Period = 30 years

Savings to Investment Ratio = 0.10

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

The expected simple payback resulting from the implementation of this projects is 15 years ($60,000 ÷ $4,000). Additional plant operating costs associated with maintaining the turbine would only degrade this finding further.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: P-1 TURBINE DRIVES
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 54000. | | |
| B. SIOH | $ 3000. | | |
| C. DESIGN COST | $ 3000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 60000. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 60000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 715. | $ 5026. | 15.61 | $ 78463. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | -1339. | $ -4593. | 20.96 | $ -96264. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 2600. | 14.74 | $ 38324. |
| N. TOTAL | | -624. | $ 3034. | | $ 20522. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ -1000.
(1) DISCOUNT FACTOR (TABLE A) 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ -14740.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -14740.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 2034.

5. SIMPLE PAYBACK PERIOD (1G/4) 29.50 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 5782.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .10
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): -8.28 %

# ECO-P2
# EFFICIENT MOTORS

**Existing.** Presently, the Boiler Plant utilizes several large motors to provide combustion air and makeup water for its boilers. These motors are standard energy efficient type with efficiencies at approximately 91%. From the Electric Model in Section 5.14, Entech identified eight (8) motors as possibly being replaced with energy efficient motors. These motors typically operate for many hours and contribute to the Base electric demand. From the Electric Model and summarized below, the eight (8) motors have an annual electric demand of 1,350 kW and electric usage of 805,679 kWh. Based on these quantities, the annual cost to operate the motors is $31,100. (Refer to Electric Model)

| Motor | Size hp | Eff | Demand kW | Usage kWh | Cost $ |
|---|---|---|---|---|---|
| #1 Forced Draft Fan | 40 | 91.1% | 149 | 100,262 | $3,700 |
| #2 Forced Draft Fan | 40 | 91.1% | 149 | 100,262 | $3,700 |
| #3 Forced Draft Fan | 50 | 91.2% | 194 | 126,376 | $4,500 |
| #3 Induced Draft Fan | 100 | 91.8% | 388 | 250,656 | $9,400 |
| Feedwater Pump #1 | 40 | 91.1% | 119 | 14,323 | $1,400 |
| Feedwater Pump #2 | 40 | 91.1% | 179 | 128,909 | $4,600 |
| Feedwater Pump #3 | 40 | 91.1% | 60 | 14,323 | $900 |
| Feedwater Pump #4 | 50 | 91.2% | 112 | 80,568 | $2,900 |
| Totals | | | 1,350 | 805,679 | $31,100 |

**Proposed.** Replace the existing motors with energy efficient motors. Energy efficient motors in the 40-100 hp range typically have an efficiency of 93% to 95%. This represents an increase of 2 to 3% in efficiency of the motors, while decreasing the existing operations. The new motors are expected to have an annual demand of 1,313 kW and

usage of 783,726 kWh. The annual cost to operate the new motors will be $30,300. (Refer to attached sheet)

| Motor | Size hp | Eff | Demand kW | Usage kWh | Cost $ |
|---|---|---|---|---|---|
| #1 Forced Draft Fan | 40 | 93.4% | 145 | 97,793 | $3,600 |
| #2 Forced Draft Fan | 40 | 93.4% | 145 | 97,793 | $3,600 |
| #3 Forced Draft Fan | 50 | 93.8% | 189 | 113,150 | $4,400 |
| #3 Induced Draft Fan | 100 | 94.7% | 376 | 242,980 | $9,100 |
| Feedwater Pump #1 | 40 | 93.4% | 116 | 13,970 | $1,400 |
| Feedwater Pump #2 | 40 | 93.4% | 175 | 125,735 | $4,500 |
| Feedwater Pump #3 | 40 | 93.4% | 59 | 13,970 | $900 |
| Feedwater Pump #4 | 50 | 93.8% | 109 | 78,335 | $2,800 |
| Totals | | | 1,313 | 783,726 | $30,300 |

Sample Calculations

Demand kW = (old eff. ÷ new eff) x old kW

Usage kWh = (old eff. ÷ new eff) x old kWh

**Construction Costs.** The estimated construction cost for the installation of new energy efficient motors is $22,500. (reference attached cost estimate)

| | |
|---|---|
| Material | $17,500 |
| Labor | 3,000 |
| Design Fee | 1,000 |
| SIOH | 1,000 |
| Total | $22,500 |

**Savings.** The annual savings resulting from the implementation of this project will be $800.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Electric Demand (kW/yr) | 1,350 | 1,313 | 37 | 2.7% |
| Electric Usage (kW/yr) | 805,679 | 783,726 | 21,935 | 2.7% |
| Energy Usage (mmBtu/yr) | 2,750 | 2,675 | 75 | 2.7% |
| Electric Cost | $31,100 | $30,300 | $800 | 2.6% |

**Maintenance Savings.** The annual maintenance savings expected for this ECO ~~is $0~~.

should have savings new motors

**Discussion.** Payback Period = 29 years

Savings to Investment Ratio = 0.54

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

This ECO is based on the assumption the existing motors do not need to be replaced and replacement is done for energy savings only. If the motors need to be replaced the economics will change significantly. Energy efficient motors generally cost 25% more than standard efficiency. Basing the economics on the difference in motor prices rather than the entire cost of a motor will lower the payback period to 3.3 years as shown below.

| | |
|---|---|
| Efficient Motor Material | $13,200 |
| Standard Motor Material | $10,600 ($13,200 ÷ 1.25) |
| Motor Price Difference | $ 2,600 ($13,200 - $10,600) |
| Payback Period | 3.3 years ($2,600 ÷ $800) |

LIFE CYCLE COST ANALYSIS SUMMARY  STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP)  LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK  REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03  FT. DETRICK STEAM STUDY
FISCAL YEAR 1995  DISCRETE PORTION NAME: P-2 HIGH EFFICIENCY MOTORS
ANALYSIS DATE: 07-21-95  ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | |
|---|---|---|---|
| A. CONSTRUCTION COST | $ 22500. | | |
| B. SIOH | $ 1000. | | |
| C. DESIGN COST | $ 1000. | | |
| D. TOTAL COST (1A+1B+1C) | $ 24500. | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 24500. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 75. | $ 527. | 15.61 | $ 8230. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 0. | $ 0. | 20.96 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 332. | 14.74 | $ 4894. |
| N. TOTAL | | 75. | $ 859. | | $ 13124. |

3. NON ENERGY SAVINGS(+) / COST(-)

| | | |
|---|---|---|
| A. ANNUAL RECURRING (+/-) | | $ 0. |
| (1) DISCOUNT FACTOR (TABLE A) | 14.74 | |
| (2) DISCOUNTED SAVING/COST (3A X 3A1) | | $ 0. |

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 0.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 859.

5. SIMPLE PAYBACK PERIOD (1G/4) 28.51 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 13124.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .54
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): -.07 %

## ECO P-3
## VARIABLE SPEED DRIVES

**Existing.** Presently, the installation at the Fort Detrick boiler plant does not include any variable speed drives for the motor driven equipment. The major electrical users in the plant are the feedwater pumps, and the forced and induced draft fans for the boilers.

The feedwater system has five constant speed pumps in parallel supplying feedwater through a common piping system to the four boilers. Only one of these pumps is required during the majority of the time during the year. And at no time, to date, has the demand required more than two pumps to maintain adequate pressure in the boiler drums. The yearly demand and usage totals using this analysis estimated to be 470 kW and 238,123 kWh. The yearly electric costs to operate these pumps, as detailed in Table 5.14.1 is estimated to be $9,900.

Electric Demand (feedwater pumps) = 470 kW/yr

Electric Usage (feedwater pumps) = 238,123 kWh/yr

Electric Cost (feedwater pumps) = $9,900 / yr

$$\left(470\ kW\ x\ \frac{\$8.97}{kW}\right) + \left(238{,}123\ kWh\ x\ \frac{\$0.024}{kWh}\right) = \$9{,}930\ use,\ \$9{,}900$$

The fans on the boilers are controlled with either variable inlet vanes on the fans, or with dampers in the air stream. In both cases the boilers demand for air flow, as dictated by load, is controlling the operation of these fans. For purposes of this ECO analysis Entech will address the savings associated with the 100 HP induced draft fan on Boiler No. 3. If the payback is acceptable for this scenario, then the remainder of the fans will be reviewed, the electric costs for the one fan only are estimated to be $9,500.

Electric Demand = 388 kW/yr
(Boiler No. 3 I.D. fan)

Electric Usage = 250,656 kWh/yr
(Boiler No. 3 I.D. fan)

Electric Cost = \$9,500 / yr
(Boiler No. 3 I.D. fan)

$$\left(388\ kW\ x\ \frac{\$8.97}{kW}\right) + \left(250{,}656\ kWh\ x\ \frac{\$0.024}{kWh}\right) = \$9{,}496\ use,\ \$9{,}500$$

**Proposed.** The proposed change for this ECO is to provide state of the art variable speed control on one of the feedwater pumps, and on the induced draft fan on Boiler No. 3.

The method of control for the feedwater pumps is to use one pump with the variable speed controller to maintain a constant line pressure of 150 psig. The system currently operates between 155 and 180 psig. Drum pressures do not generally get above 130 psig. The analysis attached recreates the existing conditions and costs, and then estimates the savings using the variable speed control on the primary pump. Refer to Table ECO P-3 for electric usage and costs associated with controlling pressure utilizing a yearly bin analysis.

The estimated demand and usage totals are 380 kW and 207,814 kWh. The electric costs associated with this pumping scenario are \$8,400.

Electric Demand = 380 kW/yr
(feedwater pumps)

Electric Usage = 207,814 kWh/yr
(feedwater pumps)

Electric Cost = $8,400 /yr

$$\left(380\ kW\ x\ \frac{\$8.97}{kW} + 207{,}814\ kWh\ x\ \frac{\$0.024}{kWh}\right) = \$8{,}395\ use,\ \$8{,}400$$

For the fan control, on Boiler No. 3, the variable speed motor will adjust air flow based on the load demand. Based on a review of the boiler logs, load demand in the winter is estimated to be at about 55% of capacity or 72,000 lb/hr out of 130,000 lb/hr during the time it operates. This boiler is operated approximately 5 months out of the year or 3,600 total hours.

Reference information published by Buffalo Forge shows that generally a fan that operates like this one utilizing a damper for control at a constant speed can reduce its power consumption by 65% by using variable speed control at 55% capacity. It is estimated that this arrangement would have a demand of 204 kW and a usage of 105,276 kWh. Note, because of the nature of fan laws, diversity correction factors have been applied to best estimate the totals. The estimated costs would be $4,400.

Electric Demand = 204 kW

$$(388\ x\ .35\ x\ 1.5\ (demand\ diversity)\ ) = 204\ kw$$

Electric Usage = 105,276 kWh

$$(250{,}656\ x\ .35\ x\ 1.2\ (usage\ diversity)\ )\ 105{,}276\ kWh$$

Electric Cost = $4,400

$$\left(204\ kW\ x\ \frac{\$8.97}{kW} + 105{,}276\ kWh\ x\ \frac{\$0.024}{kWh}\right) = \$4{,}356\ use,\ \$4{,}400$$

**Construction Cost.** The estimated costs for implementing variable speed drives as outlined is as follows. The cost for one 40 HP feedwater pump to be setup for variable speed control is $56,000. While the cost for the 100 HP induced draft fan on Boiler No. 3 is $77,000. Total construction costs for the two projects are $133,000.

(1) 40 HP Feedwater Pump

| | |
|---|---|
| Material | $29,000 |
| Labor | 21,000 |
| Design Fee | 3,000 |
| SIOH | 3,000 |
| Total | $56,000 |

(1) 100 HP I.D. Fan

| | |
|---|---|
| Material | $41,000 |
| Labor | 28,000 |
| Design Fee | 4,000 |
| SIOH | 4,000 |
| Total | $77,000 |

**Savings.** The savings associated with this ECO are as follows: For feedwater pumping the savings is $1,500. The savings for the I.D. fan on Boiler No. 3 is $5,100. Total savings for both projects is $6,600.

| Savings Summary - Feedwater Pumping | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Electric Demand(kW/yr) | 470 | 380 | 90 | 19.1% |
| Electric Usage (kWh/yr) | 238,123 | 207,814 | 30,309 | 12.7% |
| Electric Cost | $9,900 | $8,400 | $1,500 | 15.2% |

| Savings Summary - I.D. Fan on Boiler No.3 | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Electric Demand(kW/yr) | 388 | 204 | 184 | 47.4% |
| Electric Usage (kWh/yr) | 250,656 | 105,276 | 145,380 | 58.0% |
| Electric Cost | $9,500 | $4,400 | $5,100 | 53.7% |

| Combined Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Electric Demand(kW/yr) | 858 | 584 | 274 | 32% |
| Electric Usage (kWh/yr) | 488,779 | 313,090 | 175,689 | 36% |
| Electric Cost | $19,400 | $12,800 | $6,600 | 34% |

**Maintenance Savings.** The annual maintenance costs (-savings) estimated for this ECO is $2,000.

**Discussion.** Payback Period = 28 years

Savings to Investment Ratio = 0.55

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

The individual paybacks for the two are over 15 years for Boiler No. 3 I.D. fan, and over 40 years for the feedwater pump.

LIFE CYCLE COST ANALYSIS SUMMARY — STUDY: DETRICK2
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) — LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: P-3 VARIABLE SPEED DRIVES
ANALYSIS DATE: 07-19-95 ECONOMIC LIFE 20 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ 119000. | |
| B. SIOH | $ 7000. | |
| C. DESIGN COST | $ 7000. | |
| D. TOTAL COST (1A+1B+1C) | $ 133000. | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ 0. | |
| F. PUBLIC UTILITY COMPANY REBATE | $ 0. | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | $ 133000. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 600. | $ 4218. | 15.61 | $ 65843. |
| B. DIST | $ 4.25 | 0. | $ 0. | 17.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 19.97 | $ 0. |
| D. NAT G | $ 3.43 | 0. | $ 0. | 20.96 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 17.58 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 16.12 | $ 0. |
| M. DEMAND SAVINGS | | | $ 2458. | 14.74 | $ 36231. |
| N. TOTAL | | 600. | $ 6676. | | $ 102074. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) — $ -2000.
(1) DISCOUNT FACTOR (TABLE A) — 14.74
(2) DISCOUNTED SAVING/COST (3A X 3A1) — $ -29480.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ -29480.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 4676.

5. SIMPLE PAYBACK PERIOD (1G/4) — 28.44 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) — $ 72594.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= .55
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): .03 %

## 6.7 (L) Lighting

The following section contains the evaluations for the ECOs investigating the opportunities associated with lighting in the Boiler Plant. They are ECO L-1 through L-2

L-1 Boiler Plant Lighting
L-2 Exit Signs to Fluorescent

# ECO L-1
# BOILER PLANT LIGHTING

**Existing.** The Boiler Plant uses both HID (High Intensity Discharge) and Incandescent Lighting. For the most part, the HID lighting consists of metal halide and fluorescent tube type fixtures that are operated 24 hours a day. The incandescent lights are typically operated at night, or 12 hours a day, Table 5.1.3.1, the Lighting Model, estimates that the monthly lighting costs are approximately \$645 (\$7,800/yr). The monthly cost to operate the 20 incandescent lights for 12 hours a day is approximately \$65 (\$780/yr). The energy demand, usage, and cost for plant lighting are as follows:

Electric Demand = 288 kW/yr

$$\left(24\ \frac{kW}{mo}\ x\ 12\ \frac{mo}{yr}\right) = 288\ \frac{kW}{yr}$$

Electric Usage = 216,036 kWh/yr

$$\left(18{,}003\ \frac{kWh}{mo}\ x\ 12\ \frac{mo}{yr}\right) = 216{,}036\ \frac{kWh}{yr}$$

Electric Cost = \$7,800

$$\left(288\frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(216{,}036\frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$7{,}768\ \textit{use}\ \$7{,}800$$

**Proposed.** Remove all existing incandescent lights and replace with metal halide lights. Reference Table ECO L-1, which is a lighting model modification showing the replacement of twenty (20) incandescent lights with seventeen (17) metal halide lights. The output in lumens for the two methods is equivalent which implies that approximately the same lighting levels would be experienced with the proposed arrangement. With the new lighting operated in the same manner, the monthly costs calculate to be \$600 (\$7,200/yr). The cost to operate the replacement lighting would be \$23/mo (\$276/yr).

Electric Demand = 264 kW/yr

$$\left(22\ \frac{kW}{yr}\ x\ 12\ \frac{mo}{yr}\right) = 264\ \frac{kW}{yr}$$

Electric Usage = 201,876 kWh/yr

$$\left(16{,}823\ \frac{kWh}{mo}\ x\ 12\ \frac{mo}{yr}\right) = 201{,}876\ \frac{kWh}{yr}$$

Electric Cost = $7,200/yr

$$\left(264\frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(201{,}876\frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$7{,}213,\ use\ \$7{,}200\ yr$$

**Construction Cost.** The estimated construction cost for implementing the projects is $17,500. Refer to the cost estimate attached.

| | |
|---|---|
| Material | $9,500 |
| Labor | 6,000 |
| Design Fee | 1,000 |
| SIOH | 1,000 |
| Total | $17,500 |

**Savings.** The yearly cost savings for replacing the incandescent lights with metal halide, HID lighting is $600.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Electric Demand(kW/yr) | 288 | 264 | 24 | 8.3% |
| Electric Usage (kWh/yr) | 216,036 | 201,876 | 14,610 | 6.6% |
| Energy Usage (mmBtu/yr) | 737.3 | 689.0 | 48.3 | 6.6% |
| Electric Cost | $7,800 | $7,200 | $600 | 7.7% |

**Maintenance Savings.** The annual maintenance savings associated with this ECO is $1,000.

**Discussion.** Payback Period = 11 years

Savings to Investment Ratio = 1.1

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

**REVISED LIGHTING MODEL**
**FT. DETRICK**
**BUILDING 190 (BOILER HOUSE)**
**ECO L-1**

| ROOM OR AREA DESCRIPTION | FIXTURE TYPE (1) | LIGHT LEVELS (FC) | NO. OF FIX. | LAMPS PER FIXTURE | WATTS PER LAMP | TOTAL WATTS | HOURS PER WEEK | PERCENT OF KW ON-PEAK | DEMAND KW ON-PEAK | USAGE KWH PER MONTH | ELECTRIC COSTS MONTHLY DEMAND (KW) | MONTHLY USAGE (KWH) | MONTHLY COST $ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Boiler Plant - Building #190** | | | | | | | | | | | | | |
| Switchgear Room | 1.15 | | 2 | 2 | 40 | 184 | 168 | 95.0% | 0.2 | 134 | $1.57 | $3.22 | $4.79 |
| Emergency Generator Room | 1.15 | | 3 | 2 | 40 | 276 | 168 | 95.0% | 0.3 | 201 | $2.35 | $4.83 | $7.18 |
| Boiler Plant High Bay Area | 1.15 | | 18 | 1 | 400 | 8,280 | 168 | 95.0% | 7.9 | 6,037 | $70.56 | $144.89 | $215.45 |
| Boiler Plant Lower Level | 1.15 | | 8 | 1 | 400 | 3,680 | 168 | 95.0% | 3.5 | 2,683 | $31.36 | $64.40 | $95.75 |
| Boiler Plant Lower Level | 1.15 | | 7 | 1 | 1000 | 8,050 | 168 | 95.0% | 7.6 | 5,869 | $68.60 | $140.87 | $209.46 |
| Locker Room | 1.15 | | 2 | 2 | 40 | 184 | 168 | 95.0% | 0.2 | 134 | $1.57 | $3.22 | $4.79 |
| Control Panel Lights | 1.15 | | 2 | 2 | 75 | 345 | 168 | 95.0% | 0.3 | 252 | $2.94 | $6.04 | $8.98 |
| Operator Table | 1.15 | | 2 | 2 | 40 | 184 | 168 | 95.0% | 0.2 | 134 | $1.57 | $3.22 | $4.79 |
| Chemical Treatment Room | 1.15 | | 3 | 2 | 40 | 276 | 168 | 95.0% | 0.3 | 201 | $2.35 | $4.83 | $7.18 |
| Softner Room | 1.15 | | 1 | 2 | 40 | 92 | 168 | 95.0% | 0.1 | 67 | $0.78 | $1.61 | $2.39 |
| Outdoor HPS Light | 1.15 | | 1 | 1 | 150 | 173 | 84 | 50.0% | 0.1 | 63 | $0.77 | $1.51 | $2.28 |
| Boiler 5 & 6 Flood Lights | 1.15 | | 2 | 1 | 150 | 345 | 168 | 95.0% | 0.3 | 252 | $2.94 | $6.04 | $8.98 |
| Boiler #3 Burner/Control Panel | 1.15 | | 1 | 4 | 40 | 184 | 168 | 95.0% | 0.2 | 134 | $1.57 | $3.22 | $4.79 |
| New HID Lighting | 1.15 | | 10 | 1 | 100 | 1,150 | 84 | 50.0% | 0.6 | 419 | $5.16 | $10.06 | $15.22 |
| New HID Lighting | 1.15 | | 7 | 1 | 70 | 564 | 84 | 50.0% | 0.3 | 205 | $2.53 | $4.93 | $7.46 |
| Exit Signs | 1 | | 2 | 1 | 25 | 50 | 168 | 95.0% | 0.0 | 36 | $0.43 | $0.87 | $1.30 |
| TOTALS | | | 71 | | | 24,016 | | | 22 | 16,823 | $197 | $404 | $601 |

INCREMENTAL DEMAND COST $/KW = $8.97
INCREMENTAL USAGE COST $/KWH = $0.024

NOTE #1: FOR BALLASTED FIXTURES A BALLAST FACTOR OF 1.15 IS USED, INCANDESCENT FIXTURES USE 1.

G:\PROJECTS\4130.03\SS\LMODEL.WK1 30-Mar-95

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DET-LITE
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: L-1 NEW LIGHTING FOR BOILER PLAN
ANALYSIS DATE: 09-19-95 ECONOMIC LIFE 15 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | |
|---|---|---|
| A. CONSTRUCTION COST | $ | 15500. |
| B. SIOH | $ | 1000. |
| C. DESIGN COST | $ | 1000. |
| D. TOTAL COST (1A+1B+1C) | $ | 17500. |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | $ | 0. |
| F. PUBLIC UTILITY COMPANY REBATE | $ | 0. |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | $ | 17500. |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 50. | $ 352. | 12.43 | $ 4369. |
| B. DIST | $ 4.25 | 0. | $ 0. | 13.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 15.09 | $ 0. |
| D. NAT G | $ 3.43 | 0. | $ 0. | 15.86 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 13.61 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 12.64 | $ 0. |
| M. DEMAND SAVINGS | | | $ 215. | 11.85 | $ 2548. |
| N. TOTAL | | 50. | $ 567. | | $ 6917. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 1000.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 11850.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 11850.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 1567.

5. SIMPLE PAYBACK PERIOD (1G/4) 11.17 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 18767.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 1.07
(IF < 1 PROJECT DOES NOT QUALIFY)
**** Project does not qualify for ECIP funding; 4,5,6 for information only.

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): N/A

## ECO L-2
## EXIT SIGNS TO FLUORESCENT

**Existing.** Presently the Fort Detrick Boiler Plant contains two (2) exit signs. The existing signs utilize one (1), twenty five (25) watt incandescent lamp. The exit signs operate 24 hours per day and contribute approximately 95% of their connected load to the demand. Annual energy cost for these fixtures is $16.

Electric Demand = 0.6 kW/yr

$$\left(2\ fix\ x\ 1\ \frac{lamp}{fix}\ x\ 25\ \frac{watt}{lamp} \div 1{,}000\ \frac{watt}{kW}\ x\ 95\%\ on\text{-}peak\ x\ 12\ \frac{mo}{yr}\right) = 0.6\ \frac{kW}{yr}$$

Electric Usage = 437 kWh/yr

$$\left(2\ fix\ x\ 1\ \frac{lamp}{fix}\ x\ 25\ \frac{watt}{lamp} \div 1{,}000\ \frac{watt}{kW}\ x\ 168\ \frac{hrs}{wk}\ x\ 52\ \frac{wks}{yr}\right) = 437\ \frac{kWh}{yr}$$

Electric Cost = $16

$$\left(0.6\frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(437\frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$15.90\ use\ \$16$$

**Proposed.** Remove and replace all existing exit sign interior housings with a fluorescent retrofit system. The fluorescent PL retrofit system consists of a single ballast and one seven (7) watt compact fluorescent lamp. The new exit signs will consume 8 watts of electricity per fixture. The new fixtures generally have a longer life expectancy. The annual energy cost for these fixtures is $5.

Electric Demand = 0.2 kW/yr

$$\left(2\ fix\ x\ 1\ \frac{lamp}{fix}\ x\ 8\ \frac{watt}{lamp} \div 1{,}000\ \frac{watt}{kW}\ x\ 95\%\ on\text{-}peak\ x\ 12\ \frac{mo}{yr}\right) = 0.19\ \frac{kW}{yr},\ use\ 0.2\ \frac{kW}{yr}$$

Electric Usage = 133 kWh/yr

$$\left(2\ fix\ x\ 1\ \frac{lamp}{fix}\ x\ 8\ \frac{watt}{lamp} \div 1{,}000\ \frac{watt}{kW}\ x\ 168\ \frac{hrs}{wk}\ x\ 52\ \frac{wks}{yr}\right) = 133\ \frac{kWh}{yr}$$

Electric Cost = $5

$$\left(0.2\frac{kW}{yr}\ x\ \frac{\$8.97}{kW}\right) + \left(133\frac{kWh}{yr}\ x\ \frac{\$0.024}{kWh}\right) = \$5$$

**Construction Cost.** The expected construction cost for the projects will be $100.

Material $50 (2 fix. x $25/fix.)
Labor $50 (2 fix. x $25/fix.)

**Savings.** The annual cost savings resulting from the implementation of this project will be $11.

| Savings Summary | Existing | Proposed | Savings | Percent Reduction |
|---|---|---|---|---|
| Electric Demand (kW/yr) | 0.6 | 0.2 | 0.4 | 67% |
| Electric Usage (kWh/yr) | 437 | 133 | 304 | 70% |
| Energy Usage (mmBtu/yr) | 1.5 | 0.5 | 1 | 67% |
| Electric Cost | $16 | $5 | $11 | 69% |

**Maintenance Savings.** The annual maintenance savings expected with this ECO is $25.

**Discussion.** Payback Period = 2.7 years

Savings to Investment Ratio = 4.4

These are the results of the ECOs Life Cycle Analysis and a copy of it can be found attached.

Note, the impact on the Boiler Plant may be insignificant but the savings associated with changes made on a site basis could be significant. Making this change to the Boiler Plant alone can occur at the next required change out, making any immediate change is not warranted based on the minimal savings

LIFE CYCLE COST ANALYSIS SUMMARY STUDY: DET-LITE
ENERGY CONSERVATION INVESTMENT PROGRAM (ECIP) LCCID 1.080
INSTALLATION & LOCATION: FT. DETRICK REGION NOS. 3 CENSUS: 3
PROJECT NO. & TITLE: 4130.03 FT. DETRICK STEAM STUDY
FISCAL YEAR 1995 DISCRETE PORTION NAME: L-2 EXIT LIGHTING
ANALYSIS DATE: 09-19-95 ECONOMIC LIFE 15 YEARS PREPARED BY: ENTECH ENG.

1. INVESTMENT

| | | | | |
|---|---|---|---|---|
| A. CONSTRUCTION COST | $ 100. | | | |
| B. SIOH | $ 0. | | | |
| C. DESIGN COST | $ 0. | | | |
| D. TOTAL COST (1A+1B+1C) | $ 100. | | | |
| E. SALVAGE VALUE OF EXISTING EQUIPMENT | | $ 0. | | |
| F. PUBLIC UTILITY COMPANY REBATE | | $ 0. | | |
| G. TOTAL INVESTMENT (1D - 1E - 1F) | | | $ 100. | |

2. ENERGY SAVINGS (+) / COST (-)
DATE OF NISTIR 85-3273-X USED FOR DISCOUNT FACTORS OCT 1993

| FUEL | UNIT COST $/MBTU(1) | SAVINGS MBTU/YR(2) | ANNUAL $ SAVINGS(3) | DISCOUNT FACTOR(4) | DISCOUNTED SAVINGS(5) |
|---|---|---|---|---|---|
| A. ELECT | $ 7.03 | 1. | $ 7. | 12.43 | $ 87. |
| B. DIST | $ 4.25 | 0. | $ 0. | 13.56 | $ 0. |
| C. RESID | $ 2.81 | 0. | $ 0. | 15.09 | $ 0. |
| D. NAT G | $ 3.43 | 0. | $ 0. | 15.86 | $ 0. |
| E. COAL | $ .00 | 0. | $ 0. | 13.61 | $ 0. |
| F. LPG | $ .00 | 0. | $ 0. | 12.64 | $ 0. |
| M. DEMAND SAVINGS | | | $ 5. | 11.85 | $ 58. |
| N. TOTAL | | 1. | $ 12. | | $ 146. |

3. NON ENERGY SAVINGS(+) / COST(-)

A. ANNUAL RECURRING (+/-) $ 25.
(1) DISCOUNT FACTOR (TABLE A) 11.85
(2) DISCOUNTED SAVING/COST (3A X 3A1) $ 296.

B. NON RECURRING SAVINGS(+) / COSTS(-)

| ITEM | SAVINGS(+) COST(-) (1) | YR OC (2) | DISCNT FACTR (3) | DISCOUNTED SAVINGS(+)/ COST(-)(4) |
|---|---|---|---|---|
| d. TOTAL | $ 0. | | | 0. |

C. TOTAL NON ENERGY DISCOUNTED SAVINGS(+)/COST(-)(3A2+3Bd4) $ 296.

4. FIRST YEAR DOLLAR SAVINGS 2N3+3A+(3Bd1/(YRS ECONOMIC LIFE)) $ 37.

5. SIMPLE PAYBACK PERIOD (1G/4) 2.71 YEARS

6. TOTAL NET DISCOUNTED SAVINGS (2N5+3C) $ 442.

7. SAVINGS TO INVESTMENT RATIO (SIR)=(6 / 1G)= 4.42
(IF < 1 PROJECT DOES NOT QUALIFY)

8. ADJUSTED INTERNAL RATE OF RETURN (AIRR): 13.84 %

# 7.0 CONCLUSION

## 7.1 General

The thirty ECOs in this report cover Boiler Plant improvements and changes for the site steam system in general terms. Of the thirty ECOs in this report close to twenty five of them relate directly to the equipment in and operation of the Boiler Plant. The remaining ECOs relate to steam savings that indirectly impact the Boiler Plant.

A summary of ECOs in the order presented in Section 6 is shown in Table 7.1.1. Included with each ECO listed are the construction costs, the annual energy savings, the annual maintenance savings, the LCCID payback periods and SIR.

# ECO Summary for Fort Detrick
## Table 7.1.1

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Energy Savings (mmBtu) |
|---|---|---|---|---|---|---|---|
| B-1 | Feedwater Treatment | N/A | N/A | N/A | N/A | N/A | N/A |
| B-2 | Stack Economizers | $253,000 | $16,500 | ($10,000) | 34 | 0.85 | 1485 (No.6 Oil)<br>3899 (Nat. Gas) |
| B-3 | Automatic Blowdown Controls | $145,000 | $9,800 | $3,000 | 11 | 1.7 | 2860 (Nat. Gas) |
| B-4 | New Burners | $200,000 | $14,900 | $0 | 13 | 1.5 | 2521 (No.6 Oil)<br>2299 (Nat. Gas) |
| B-5 | Oxygen Trim Controls on Boiler | $75,000 | $18,000 | ($1,000) | 4.4 | 4.8 | 5248 (Nat. Gas) |
| B-6 | Air Preheaters | $1,096,000 | $34,100 | ($10,000) | 45 | 0.60 | -1520 (kWh) -6979 ($kW)<br>6336 (No.6 Oil)<br>9929 (Nat .Gas) |
| B-7 | Supply Combustion Air from Ceiling | $58,000 | $3,900 | | 17 | 1.5 | -199 (kWh) -870 ($Kw)<br>882 (No.6 Oil)<br>987 (Nat. Gas) |
| B-8 | Update Instruments & Controls | N/A | N/A | N/A | N/A | N/A | N/A |
| B-9 | New Steam Metering | $54,000 | $950 | ($1,000) | ∞ | 0.09 | 271 (Nat. Gas) |
| O-1 | Shut off Standby Boilers | $5,000 | $87,700 | $0 | 0.13 | 158 | 10995 (Nat. Gas) |
| O-2 | Improve Boiler Sequencing | $5,000 | $41,000 | $0 | 0.12 | 171 | -2273 (No.6 Oil)<br>13655 (Nat. Gas) |
| O-3 | Summer Shutdown of Boiler Plant | $4,058,000 | ($13,500) | ($25,000) | ∞ | 0.63 | -17259 (kWh)<br>-12881 ($kW)<br>-133250 (No.2 Oil)<br>-78 (No.6 Oil)<br>224817 (Nat. Gas) |
| O-4 | Replace Less Efficient Boilers | $1,772,000 | $121,000 | $0 | 14.9 | 1.4 | 15031 (No.6 Oil)<br>22410 (Nat. Gas) |
| O-5 | Fuel Use Selection Plan | $5,000 | $215,000 | ($10,000) | 0.02 | 1019 | -271508 (No.6 Oil)<br>284831 (Nat. Gas) |

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Energy Savings (mmBtu) |
|---|---|---|---|---|---|---|---|
| O-6 | Alternate Fuels | $5,000 | $131,000 | $0 | 0.04 | 549 | 38192 (Nat. Gas)<br>*simulated |
| S-1 | Cogeneration | $10,045,000 | $735,800 | ($457,000) | 13.7 | 0.63 | 199046 (kWh)<br>719304 ($kW)<br>270118 (Nat. Gas) |
| S-2 | New Boiler Plant | $4,304,000 | $162,800 | ($200,000) | ∞ | 0.09 | 18325 (No.6 Oil)<br>31888 (Nat. Gas) |
| S-3 | Steam Pressure Reduction | $112,000 | $39,700 | $0 | 2.8 | 7.4 | 11505 (Nat. Gas) |
| S-4 | Improve Condensate Return | $321,000 | $43,500 | $0 | 7.4 | 2.2 | 12696 (Nat. Gas) |
| S-5 | Correct Sizing of Traps (Deleted) | N/A | N/A | N/A | N/A | N/A | N/A |
| S-6 | Steam & Condensate Metering | $247,000 | $14,500 | ($15,000) | ∞ | 0.33 | 4217 (Nat. Gas) |
| S-7 | Insulate Steam & Condensate Line | $1,008,000 | $184,700 | $0 | 5.5 | 3.8 | 53264 (Nat. Gas) |
| S-8 | Replace Steam Humidification Ultrasonic | $87,000 | ($1,000) | ($2,000) | ∞ | -0.17 | 2132 (Nat. Gas)<br>-92 (kWh)<br>-834 ($kW) |
| S-9 | Sewage Storage Tank Insulation | $298,000 | $7,300 | ($1,000) | 47 | 0.46 | 108 (Nat. Gas) |
| S-10 | Reduce Contaminate Sewage | $373,000 | $37,700 | $0 | 9.9 | 2.1 | 11021 (Nat. Gas) |
| P-1 | Turbine Drives on Feedwater Pumps | $60,000 | $4,000 | ($1,000) | 30 | 0.10 | 715 (kWh)<br>3034 ($kW)<br>-1339 (Nat. Gas) |
| P-2 | Efficient Motors | $22,500 | $800 | $0 | 29 | 0.54 | 75 (kWh) 332 ($kW) |
| P-3 | Variable Speed Drives | $133,000 | $6,660 | ($2,000) | 28 | 0.55 | 600 (kWh)<br>2458 ($kW) |
| L-1 | Boiler Plant Lighting | $17,500 | $600 | $1,000 | 11 | 1.3 | 50 (kWh)<br>215 ($kW) |
| L-2 | Exit Sign to Fluorescent | $100 | $11 | $25 | 2.8 | 5.3 | 1 (kWh)<br>4 ($kW) |

The lists of the recommended or not recommended ECOs are shown in the following sections. In addition to the summary information for each ECO a comment is added to each ECO in the two lists which relates to Entech's opinion on which category the project falls under. Below is the criteria that is used to categorize the report's findings (ie. ECIP, Non-ECIP etc.). Qualifying for ECIP requires a project to have a low limit for construction, and an acceptable payback and investment ratio. In addition it cannot be an operation and maintenance project which is defined as:

> **O & M Energy Projects:** An O & M Energy Project is one that results in needed maintenance and repair to an existing facility, or replaces a failed or failing existing facility, and also results in energy savings.

The following criteria is the basis to recommend or not-recommend ECOs for this report. The criteria is from the scope for this project which is included in Appendix 8.7

Qualifications for Project Recommendation:

1. **ECIP:** Projects that have \$300,000 construction cost, SIR > 1.25, payback < 10 years.

   **Non-ECIP:** Projects that do not meet 1, or they fall under 2 or 3. (If an ECO is recommended and does not fall under 2 or 3, then it will be considered Non-ECIP General)

2. **O & M Projects (by definition):** \$300,000 construction cost, SIR > 1.25, payback < 10 years.

3. **Low Cost/No Cost Projects:** Fort Detrick can implement with their own resources

4. **Non-feasible:** ECOs that are not recommended based on findings for 1, 2, and 3, or because of reasons stated in the individual ECO discussion section and/or the not recommended table.

## 7.2 Recommended ECOs

Of the thirty ECOs addressed, ten have been found to be acceptable, and they are listed in Table 7.2.1. They are listed from highest to lowest savings to investment ratio.

**Recommend ECO List for Fort Detrick**
**Table 7.2.1**

| | ECO # | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Comment |
|---|---|---|---|---|---|---|---|---|
| 1 | O-5 | Fuel Usage Selection Plan | $5,000 | $215,000 | ($10,000) | 0.02 | 1,019 | Non-ECIP (LC/NC) |
| 2 | O-6 | Alternate Fuels | $5,000 | $131,000 | $0 | 0.40 | 549 | Non-ECIP (LC/NC) |
| 3 | O-2 | Improve Boiler Sequencing | $5,000 | $41,000 | $0 | 0.12 | 171 | Non-ECIP (LC/NC) |
| 4 | O-1 | Shut-off Stand by Boilers | $5,000 | $37,700 | $0 | 0.13 | 158 | Non-ECIP (LC/NC) |
| 5 | S-3 | Steam Pressure Reduction | $112,000 | $39,700 | $0 | 2.8 | 7.4 | Non-ECIP (LC/NC) |
| 6 | L-2 | Exit Signs to Fluorescent | $100 | $11 | $25 | 2.8 | 4.4 | Non-ECIP |
| 7 | B-5 | Oxygen ($O_2$)Trim Controls on Boilers | $75,000 | $18,000 | $1,000 | 4.4 | 4.8 | Non-ECIP |
| 8 | S-7 | Insulate Steam & Condensate Lines | $1,008,000 | $184,700 | $0 | 5.5 | 2.9 | Non-ECIP (O&M) |
| 9 | S-4 | Improve Condensate Return | $321,000 | $43,500 | $0 | 7.4 | 2.2 | Non-ECIP (O&M) |
| 10 | S-10 | Reduce Contaminated Sewage | $373,000 | $37,700 | $0 | 9.9 | 2.1 | ECIP |
| | | **Total** | **$1,891,100** | **$747,611** | **($8,975)** | **2.6** | | |

The list of recommended ECOs reflects the general findings for the site. The Boiler Plant and Systems were found to be in excellent condition and their savings opportunities are minimal. Only ECO B-5, Oxygen Trim Controls, physically addresses the boiler systems in any way, while L-2 Exit Signs to Fluorescent provides an opportunity for lighting changes. The top five ECOs for the project by SIR value relate to low cost/no cost improvements dealing with use (ECO O-5) and acquisition (ECO O-6) of fuels, the sequencing of boilers (ECO O-2), the practice of banking the boilers (ECO O-1), and lowering the site's delivered steam pressure (ECO S-3).

The only significant interactive savings is between ECOs O-5 and O-6. Reducing gas use as recommended O-5 would reduce the savings found by O-6 if both are adopted. The combined savings could reach $250,000 if both can be adopted.

Two major O&M projects deal with the distribution piping on the site. Primarily with the piping that either is directly buried or located in underground tunnels. The two projects, ECOs S-4 and S-7, probably should be combined into one O&M project because together they offer opportunities for further savings because of their relationship.

The last project in the recommended list is ECO S-10, which deals with the escalation of contaminated sewage seen every summer. This project is the combination of the physical rerouting of sewage, and the possibility of changes in practice for water use. For now Entech feels that the construction costs as

presented relate directly to a change in the site's design and therefore qualifies it as an ECIP project.

A review of the ten recommended ECOs shows that for an investment of close to $2 million dollars in construction costs, a savings of over $1/2 million in energy costs might be realized. With operating changes and strategies constituting the majority of the savings.

## 7.3 Non-Recommended ECOs

Twenty ECOs out of the original thirty are not-recommended for implementation. Those ECOs were not recommended ECOs for various reasons including the criteria in Section 6.1. The not-recommended are listed in Table 7.3.1. They are categorized in the same order as they were presented in Section 6. Omitted from that list are the recommended ECOs found in Section 7.2. Included in the table are ECO descriptions, savings, maintenance savings (costs), LCCID payback periods and SIRs and a general comment about the ECO.

## Not Recommended ECO List for Fort Detrick
## Table 7.3.1

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Comments |
|---|---|---|---|---|---|---|---|
| B-1 | Feedwater Treatment | N/A | N/A | N/A | N/A | N/A | No proposed changes |
| B-2 | Stack Economizers | $253,000 | $16,500 | ($10,000) | 34 | 0.85 | Non feasible-Boiler 5 & 6 to be used less |
| B-3 | Automatic Blowdown Controls | $145,000 | $9,800 | $3,000 | 11 | 1.7 | Non feasible-present method acceptable |
| B-4 | New Burners | $200,000 | $14,900 | $0 | 13 | 1.5 | Non feasible-Oxygen Trim only recommended for Boiler No.3 |
| B-6 | Air Preheaters | $1,096,000 | $34,100 | ($10,000) | 45 | 0.60 | Non feasible-fan changes required |
| B-7 | Supply Combustion Air from Ceiling | $58,000 | $3,900 | | 17 | 1.5 | Non feasible-fan changes required |
| B-8 | Update Instruments & Controls | N/A | N/A | N/A | N/A | N/A | No proposed changes |
| B-9 | New Steam Metering | $54,000 | $950 | ($1,000) | $\infty$ | 0.09 | Non feasible-from energy stand point |
| O-3 | Summer Shutdown of Boiler Plant | $4,058,000 | ($13,500) | ($25,000) | $\infty$ | 0.63 | Non feasible-negative payback |
| O-4 | Replace Less Efficient Boilers | $1,772,000 | $121,000 | $0 | 14.9 | 1.4 | Non feasible-from energy stand point |
| S-1 | Cogeneration | $10,045,000 | $735,800 | ($457,000) | 13.7 | 0.63 | Non feasible-electric & fuel costs to low to pay |
| S-2 | New Boiler Plant | $4,304,000 | $162,800 | ($200,000) | $\infty$ | 0.09 | Non feasible-from energy stand point |
| S-5 | Correct Sizing of Traps (Deleted from scope) | N/A | N/A | N/A | N/A | N/A | Not addressed-Deleted from scope |

| No. | Description | Const. Cost | Annual Energy Savings | Annual Maint. Savings | LCCID Payback | LCCID SIR | Comments |
|---|---|---|---|---|---|---|---|
| S-6 | Steam & Condensate Metering | $247,000 | $14,500 | ($15,000) | ∞ | 0.33 | Non-feasible-negative payback |
| S-8 | Replace Steam Humidification Ultrasonic | $87,000 | ($1,000) | ($2,000) | ∞ | -0.17 | Non-feasible-negative payback |
| S-9 | Sewage Storage Tank Insulation | $298,000 | $7,300 | ($1,000) | 47 | 0.46 | Non feasible-from energy stand point |
| P-1 | Turbine Drives on Feedwater Pumps | $60,000 | $4,000 | ($1,000) | 30 | 0.10 | Non feasible-from energy stand point |
| P-2 | Efficient Motors | $22,500 | $800 | $0 | 29 | 0.54 | Non feasible-from energy stand point |
| P-3 | Variable Speed Drives | $133,000 | $6,660 | ($2,000) | 28 | 0.55 | Non feasible-from energy stand point |
| L-1 | Boiler Plant Lighting | $17,500 | $600 | $1,000 | 11 | 1.1 | Non feasible-present lighting acceptable |